

New Scientist

WEEKLY 2 April 2022

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The Ryman Prize is an international award aimed at encouraging the best and brightest thinkers in the world to focus on ways to improve the health of older people.

The world's ageing population means that in some parts of the globe – including much of the Western world – the population aged 75+ is set to almost triple in the next 30 years.

Older people face not only the acute threat of COVID-19, but also the burden of chronic diseases including Alzheimers and diabetes.

At the same time the health of older people is one of the most underfunded and poorly resourced areas of research.

To stimulate fresh efforts to tackle the problems of old age, we're offering a NZ\$250,000 (£130,000) annual prize for the world's best discovery, development, advance or achievement that enhances quality of life for older people.

The Ryman Prize is awarded each year by the Prime Minister of New Zealand. It was first awarded in 2015 to Gabi Hollows, co-founder of the Hollows Foundation, for her tireless work to restore sight for millions of older people in the developing world.

Since then world-leading researchers Professor Henry Brodaty, Professor Peter St George-Hyslop, Professor Takanori Shibata, Dr Michael Fehlings and Professor Miia Kivipelto have all won the prize for their outstanding work.

In 2021 Professor Kenneth Rockwood, a Canadian geriatrician, academic and anti-ageism campaigner whose research into frailty has had a huge impact, was awarded the prize by the Right Honourable, Jacinda Ardern, Prime Minister of New Zealand.

If you have a great idea or have achieved something remarkable like Kenneth and our six other prize winners, we would love to hear from you.

Entries for the 2022 Ryman Prize close at 5pm on Friday, July 15, 2022 (New Zealand time).

Go to rymanprize.com for more information.



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MARK HIGGINS/GETTY IMAGES

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Instant expert: Meet your brain

Find out everything you have ever wanted to know about the most fascinating object in the universe: your brain. Six expert speakers will teach you how our brains learn to speak, how they store memories, why they need to sleep and what we understand about empathy, emotions and consciousness. At the British Library in London on 23 April at 10am BST.

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Discovery

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Podcast

Weekly

This week Rowan Hooper speaks to climate scientist Peter Stott about recent extreme weather events. The team also chat about black hole paradoxes and review a compelling sci-fi opera in New York called *Upload*, in which a daughter comes to terms with her father's decision to die in order to have his consciousness uploaded to a computer.

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Dig carefully Learn how to excavate on our tour of Mycenaean sites



Space oddity Clearest image yet of odd radio circles

Video

Stone breaker

By using sound to move objects through the body, researchers at the University of Washington are helping people pass kidney stones without invasive surgery. Ultrasound bursts can break up the stones without the need for sedation. The project is part funded by NASA to help astronauts reduce the risk of kidney stones during long missions.

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Newsletter

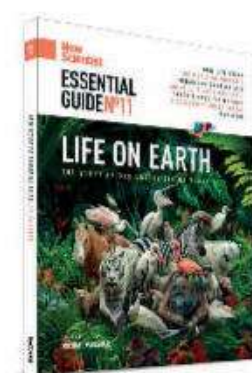
Distant galaxies

Thanks to the MeerKAT telescope in South Africa, we have the best image yet of one of the weirdest phenomena in space. Reporter Leah Crane explains how new observations of "odd radio circles" that are 1 million light years across have revealed the central galaxies and supermassive black holes at their heart.

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"He's this hologram, a digital uploaded version of himself – but is he really him?"



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**GLOBAL CHALLENGES
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Europe must re-energise

The countdown to a painful winter has already begun

“THE time to repair the roof is when the sun is shining,” US president John F. Kennedy once said. It is an adage that Europe must now wrestle with.

With spring blossoming even as war continues to darken the continent, it is hard to spend too much time thinking about next winter. Yet the geopolitical uncertainty created by Russia’s invasion of Ukraine means volatile energy prices are guaranteed this year. UK energy bill projections for October have yo-yoed with oil and gas prices in recent weeks, from a high of £3000 a year on average to a still-very-high low of £2500.

Governments must act now. The European Union already has – its recent energy strategy mandates that gas stores be replenished by winter and calls for a diversification of gas supplies. This bolsters

existing plans for renewables, energy efficiency and hydrogen. By contrast, the UK’s long-trailed energy plan was delayed again this week, as winter draws ever closer.

When new energy security strategies for Europe arrive, it is essential that they align with climate change goals. False solutions abound, such as kick-starting a UK fracking

“It is essential that new energy security strategies for Europe align with climate change goals”

industry, even though that has already been tried without success (see page 14).

Thankfully, the answers are already clear. Wind and solar power should be turbocharged, and ideological barriers such as vetoes for onshore turbines in England must be lifted. More electricity links are

required between countries, like the UK-Denmark one due to be finished next year. Energy efficiency needs serious government support, and electrification of cars and heating must be accelerated. And, yes, some mix of nuclear power, more energy storage or carbon-capture power stations will be required to support renewables when the sun isn’t shining.

Individuals can’t solve the climate or energy crises on their own, but as we detail on page 20, there are things homeowners can do to help. People on lower incomes need support to cope with high energy prices. But for those able to pay, there has never been a better time to “repair” that roof, with proper insulation and solar panels. Winter is sooner than you think. Let’s seize the opportunity to make sure we weather it. ■

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GLENN NICHOLLS/AFP VIA GETTY IMAGES

Environment

No respite for coral

The Great Barrier Reef is being affected by warm seas despite the cooling effect of La Niña, reports **Adam Vaughan**

UNUSUALLY warm ocean temperatures have turned corals white on Australia's Great Barrier Reef in the first-ever mass bleaching under the cooling conditions created by the La Niña weather pattern.

An official analysis of aerial surveys published on 25 March found mass bleaching across all four of the reef's management areas, with the north and central parts of the World Heritage Site worst hit. The impact has been less severe in the south of the reef.

"What we're seeing at the Great Barrier Reef is very worrying," says

Miriam Reverter at the University of Plymouth in the UK.

Warmer oceans under climate change have led to an increase in mass-bleaching events at the world's largest reef: this is the sixth since modern records began in 1988, and the fourth in just seven years.

Ocean temperatures at the reef during March have been between 0.5°C and 2°C above average in most places, and up to 4°C higher in some spots. Normally, the water would be expected to start getting cooler as the southern hemisphere autumn arrives.

The bleaching is particularly notable for happening when the Pacific region is in a cooling phase brought about by La Niña. The worst mass-bleaching event happened in 2016, the planet's hottest year on record, when an El Niño warming phase was in effect.

Terry Hughes at James Cook University in Australia tweeted that the latest mass bleaching was "a grim milestone during

"We thought La Niña could be a safe period when coral reefs could recover. Turns out it's not"

Bleached coral on the Great Barrier Reef in March

what should have been a cooler (La Niña) summer".

Reverter says the milestone means there is increasingly little respite for coral. "Coral reef scientists were thinking there would be some years when coral reefs could recover," she says. "We thought it [La Niña] could be a safe period. Turns out it's not."

Whether the cumulative impact of more frequent mass-bleaching events makes coral more vulnerable to new bleaching is still being researched, says Reverter. But she says there is evidence that the coral reef species dying off in the greatest numbers during mass bleaching are those with a physically complex, more three-dimensional structure. Their loss hurts the reef's ability to provide a habitat for fish and to mitigate coastal flooding.

The Great Barrier Reef Marine Park Authority, which conducted the surveys using helicopters and small planes, said on its website that the bleached coral could still recover if the waters cool, as happened in 2020 when there was relatively little coral die-off despite the most widespread bleaching ever.

UNESCO, which awarded the reef World Heritage status, last year stopped short of placing the natural wonder on a list of sites in danger because of the impacts of climate change, after lobbying by the Australian government. Hughes and other researchers have said the decision was denying the scientific evidence.

While the Great Barrier Reef is being affected at the moment, Reverter says it will be important to monitor other coral in the Pacific and Indian oceans in the coming months, to see whether heat stress triggers more widespread bleaching. ■

Ancient Britons evolved to survive

DNA from bones shows how these people adapted to keep healthy in their sun-starved land once they had turned to farming, finds **Michael Marshall**

NATURAL selection was at work on Bronze Age Britons, ancient DNA reveals. Within the past 4500 years, evolution has acted on genes involved in the production of vitamin D – which people living in Britain are sometimes short of due to a lack of sunlight for much of the year.

The genetic changes have had knock-on effects on other traits, from the ability of people to digest milk to their skin colour.

One of the ways evolutionary change can happen is through natural selection: genetic variants that are beneficial become more common in the population because individuals that carry them are more likely to reproduce.

In recent years, geneticists have collected DNA from the remains of thousands of people who lived in Britain over the millennia, so it is possible to see natural selection by looking for genetic variants becoming more or less common.

“In some cases, the change is so dramatic that you can rule out this happening by chance, and that’s when we would posit that selection is driving this,” says Jonathan Terhorst at the University of Michigan.

Terhorst has developed a new method of analysing ancient DNA for signs of natural selection. Unlike previous techniques, it doesn’t assume that selection is equally intense throughout the study period, as that is unrealistic. “The novelty here is that we can really localise selection to within a few thousand years, and say ‘this is what’s being selected,’” says Iain Mathieson at the University of Pennsylvania, who has worked with Terhorst to apply the technique to ancient Britons.

The new approach impresses Claire-Elise Fischer, who is at the University of York in the UK. “It’s really amazing,” she says. “We’re all going to use the method.”

Terhorst and Mathieson have now used the new technique to examine DNA from 529 ancient Britons from the past 4500 years, enhanced with genetic data from 98 present-day individuals.

“All these genes under selection can be linked to a need for increased vitamin D and calcium”

They found seven regions of the genome with strong evidence of selection (bioRxiv, doi.org/hnhz).

To their surprise, there was a pattern. “All these genes that are under selection can plausibly be linked to natural selection for increased vitamin D and calcium,” says Mathieson.

That finding fits into an existing body of knowledge about the role of vitamin D in recent human evolution, which has driven genetic and cultural adaptations in some populations. At the heart of this is the health function of

vitamin D. It helps us to absorb dietary calcium, strengthening bones. Children who are deficient in vitamin D can develop soft bones, a condition called rickets.

Our bodies make vitamin D when our skin is exposed to ultraviolet radiation in sunlight. When humans first evolved in Africa, there was no shortage of sunlight. However, when people migrated away from the tropics, they found themselves in places where the sunlight reaching them is less intense and the days can be shorter. Britain’s cloudy skies didn’t help either.

Nina Jablonski at Pennsylvania State University, who has spent decades unpicking the significance of vitamin D on human populations, says Britain has “a punishingly low and highly seasonal UV regime”.

Unable to produce enough vitamin D, Bronze Age Britons adapted. One shift, which Mathieson and Terhorst saw in the DNA they examined, was towards lighter skin. Skin pigmentation protects against UV, which is good in the tropics as it guards against skin cancer, but can limit

vitamin D production in Britain.

It may seem odd that this shift only happened in the past few thousand years, when people have lived in Britain for much longer than that. However, the earlier inhabitants were hunter-gatherers who could get vitamin D by eating oily fish.

Cheddar Man, who lived in Britain about 10,000 years ago, had very dark skin, and some Irish people from about 5000 years ago had moderately dark skin.

Natural selection for paler skin only really kicked in when people started getting most of their food from crop farming, leaving them prone to vitamin D deficiency, says Mathieson.

Jablonski agrees this would create evolutionary pressure. “They’re going to be at the sharp end of natural selection,” she says.

People can also compensate for a lack of vitamin D by consuming lots of calcium in their diet. Milk is an excellent source, but for most of our species’ existence we could only digest it as babies. After that, our bodies stopped making the lactase enzyme that digests the lactose sugar, so drinking milk caused indigestion.

However, in Bronze Age Britain there was strong selection for producing lactase even into adulthood, allowing people to drink milk throughout their lives. Today, most adults of European origin can drink milk, whereas many other populations remain lactose-intolerant beyond infancy.

The study illustrates the importance of vitamin D, says Jablonski, because the lack of it forced evolution to find “multiple strategies” to help Bronze Age Britons survive. “Virtually everything in the body requires vitamin D,” she says, so it isn’t surprising that a shortage provoked rapid evolution. ■

LENNART LARSEN/NATIONAL MUSEET



A reconstruction of a typical Bronze Age settlement

Technology

Virtual computer contained within an AI could help crunch numbers faster

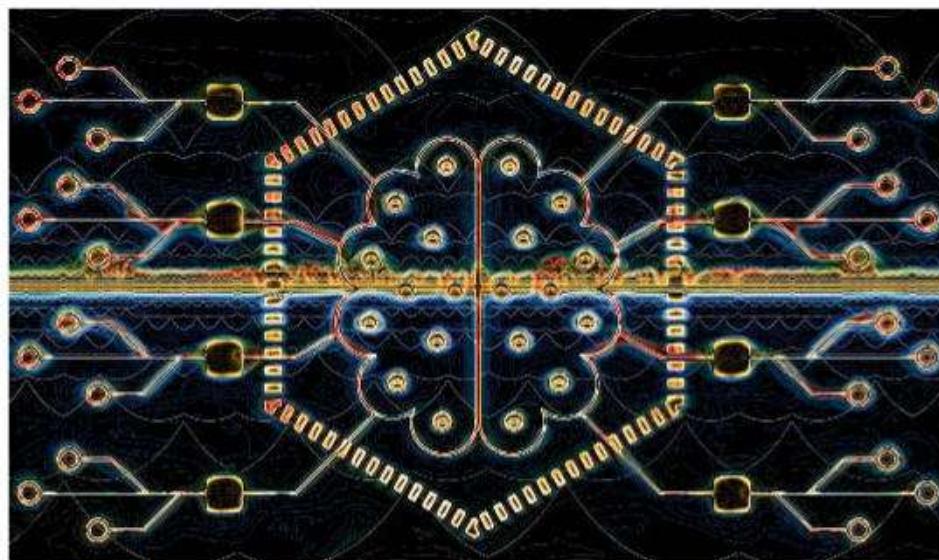
Matthew Sparkes

AN ARTIFICIAL intelligence that mimics the operation of a standard computer within its neural network could speed up certain calculations. Researchers have used it to put an AI inside an AI and play *Pong*.

If you want a computer to do something, you have to write code that manipulates bits of data. But if you code an AI-driven neural network, you have to train it with feedback before it can do anything. For instance, a neural network can distinguish between photos of cats and dogs after being shown thousands of examples and told if its guesses are correct.

Now Jason Kim and Dani Bassett at the University of Pennsylvania have a new approach, in which a neural network runs a code, just like an ordinary computer.

A neural network is a series of nodes, or artificial neurons, that takes an input and returns a changed output. The pair calculated what effect individual artificial neurons had, and used this to piece together a very simple neural network that could carry out basic tasks, such as addition.



An abstract illustration of a neuromorphic computer chip

Kim and Bassett then linked several networks together in chains so they could do more complex operations, replicating the behaviour of the logic gates found in computer chips. These chains were combined to make a network that could do things a classical computer can, including running a virtual neural network and a playable version of the game *Pong* (arxiv.org/abs/2203.05032).

The virtual neural network can also drastically simplify splitting up huge computational tasks. These are often spread over many processors to gain speed, but take more power to be split into chunks that can be run independently by separate chips, then recombined.

An emerging breed of machine called a neuromorphic computer, designed to efficiently run AI software, may also be able to help these virtual networks work faster. While a computer uses its CPU to carry out tasks, and stores data in memory, a neuromorphic

computer uses artificial neurons to both store and compute, lowering the number of operations it must carry out. Neuromorphic computers may also make it easier for software to accurately work with continuous variables, such as those in physics simulations.

Francesco Martinuzzi at Leipzig University in Germany says neural networks running code could squeeze better performance out of neuromorphic chips. "There will definitely be specific applications where these computers are going to be outperforming standard computers. And by far, I believe."

Abdelrahman Zayed at Montreal Polytechnic in Canada says this could be exciting, so long as the chains can avoid long calculations failing if an algorithm forgets the beginning as it is learning the end.

These neural networks would also need to be scaled up. "Computers don't just have one or two logic gates – a CPU will have billions of transistors," says Zayed. "Just because it worked for two or three gates, that doesn't necessarily mean that it will scale up to billions." ■

Genetics

Plans to use CRISPR gene editing to make hypoallergenic cats

THE two genes for the protein that is mainly responsible for allergic reactions to cats have been deleted from cat cells using CRISPR gene editing. It is a first step towards creating hypoallergenic cats, says US-based company InBio.

"The estimated timeline for this is several years," says Nicole Brackett, who leads the CRISPR cat team at InBio.

About 1.5 per cent of people have

allergic reactions to cats. The main cause of this is a small protein called Fel d 1 that is secreted by salivary and skin glands. It is spread over cats' fur when felines clean themselves and can become airborne as the fur dries.

Fel d 1 consists of two different subunits, and there are two genes, called *CH1* and *CH2*, encoding each subunit. When Brackett and her colleagues compared the sequences of the *CH1* and *CH2* genes in domestic cats with those in other cat species, such as lions, tigers, cougars and fishing cats, they found many changes.

Because the sequences of genes with key functions tend to change little if at all, this suggests that Fel d 1 isn't essential. The only way to find out for sure, however, will be to see what happens to cats that cannot produce any Fel d 1.

The team has now deleted either the *CH1* or the *CH2* gene from cat cells growing in culture using the CRISPR genome editing technique (*The CRISPR Journal*, doi.org/hnh8).

"Plans to modify moggies to reduce allergic reactions to cats are more feasible thanks to CRISPR"

The next step will be to delete all copies of the two genes at once, and to confirm that this prevents cells making the Fel d 1 protein. Only then will the team try to create cats that lack the genes.

"[We have] no particular cat breeds in mind at the moment," says Brackett.

In the 2000s, at least two other companies announced plans to modify moggies to eliminate Fel d 1, but neither managed it. However, achieving this is now more feasible thanks to the development of CRISPR in 2012. ■

Michael Le Page

Vaccines' effects on the heart

With the mRNA covid-19 vaccines being delivered to growing numbers of young people, researchers are looking again at the rare risk of myocarditis, reports **Clare Wilson**

AS THE UK offers a covid-19 vaccine to children aged 5 to 11, and officials consider the benefits of a fourth jab for adults, we still have an uncertain picture about the risks to the heart.

High-income countries are mainly administering the Pfizer/BioNTech and Moderna vaccines to their citizens. Based on mRNA, these contain a strand of genetic material that instructs cells to make the SARS-CoV-2 virus's spike protein, prompting an immune response that protects against severe disease. These mRNA vaccines are effective, but in rare cases they have been linked to heart muscle inflammation, known as myocarditis.

Myocarditis often causes chest pain and breathlessness, which usually resolve without treatment. In severe cases, however, it can trigger heart damage.

Inflammation signals that the immune system's activity is raised, but how myocarditis specifically comes about is unclear. "Arguably, it isn't a single disease," says Tefvik Ismail, a cardiologist at King's College London, who has advised the UK Health Security Agency on the issue, but spoke to *New Scientist* in a personal capacity. Myocarditis is also linked to other vaccines, medicines and to covid-19 itself, but regardless of cause, it is more common in males and younger people.

In December 2021, work led by a team at the University of Oxford looked at the prevalence of myocarditis after a covid-19 vaccine in more than 42 million people aged 13 or over in England. Males under 40 were most at risk. There were an additional 12 myocarditis events per 1 million males in the 28 days after a second Pfizer/BioNTech vaccine, as well as an additional 13 events after a third jab ([medRxiv, doi.org/hnmn](https://doi.org/10.1101/2021.12.15.21268888)).



A child being given a covid-19 vaccination in Paris, France

"Younger people's lower covid-19 risk makes it difficult to assess the vaccines' pros and cons"

12

Additional myocarditis cases per 1 million males aged 13 to 40 in England after a second Pfizer/BioNTech vaccine dose

13

Additional myocarditis cases per 1 million males aged 13 to 40 after a third jab

7

Additional myocarditis cases per 1 million males aged 13 to 40 after covid-19 infection

Among this group, myocarditis was more common after the vaccines than it was after covid-19 itself, which caused an additional seven myocarditis cases. This contradicts an August 2021 US study, in which myocarditis after covid-19 was six times more likely than it was post-vaccination.

Unfortunately, varying myocarditis definitions make it difficult to compare country-to-country data, says Ismail.

Although the cases have been mainly linked to mRNA vaccines, the Oxford study also reported an additional 14 myocarditis events after a second Oxford/AstraZeneca dose, which is based on a different technology. It is therefore unclear whether the cases are linked to the spike protein or perhaps to a more universal vaccine component.

A study released last month adds to the uncertainty. A team at the University of Alberta, Edmonton, in Canada reviewed 46 studies on heart inflammation after an mRNA covid-19 vaccine. Male teens and young adults were most at risk, but the estimated prevalence ranged from 50 to 139 cases per million.

When it comes to children, 4.3 males and two females aged

5 to 11 develop myocarditis out of every 1 million second Pfizer/BioNTech doses, according to the US Centers for Disease Control and Prevention. "Given that there have been a few millions of vaccines given, we should be reassured by these estimates," says Russell Viner at University College London.

Nevertheless, the UK's Joint Committee on Vaccination and Immunisation (JCVI) was hesitant to recommend a low-dose jab for 5 to 11-year-olds. In February, the JCVI announced that this age group could receive a Pfizer/BioNTech dose on a "non-urgent" basis. England is due to roll these out this month, with programmes under way in the rest of the UK.

Myocarditis becomes less likely with a longer interval between vaccine doses. Rates are therefore expected to be lower in the UK, which administers doses 12 weeks apart, versus four weeks apart in the US, says Ismail. But the condition could become an issue as health officials consider fourth doses. In the UK, fourth vaccines are mainly being offered to older people, who are at a higher risk of covid-19 but not myocarditis.

Myocarditis aside, severe covid-19 has been linked to strokes, sepsis and even to the onset of diabetes, suggesting that the vaccines' benefits outweigh any risk. While the dominant omicron variant is less virulent than its predecessors, more than 14,000 people were admitted to hospital with covid-19 in the past week in the UK.

Younger people's lower risk of severe illness from covid-19 makes it difficult to assess the vaccines' pros and cons for them, says Ismail. There are rare serious complications from infection but also rare adverse events from the vaccines, he says. "There's a lot we don't know," says Ismail. ■

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	Feb 17 - Feb 18	Feb 18 - Feb 19	Feb 19 - Feb 20	Feb 20 - Feb 21	Feb 21 - Feb 22
Net Asset Value	30.8%	-11.2%	5.2%	74.2%	-31.7%
Share Price	32.5%	-8.3%	3.1%	97.2%	-36.5%
MSCI China Index	32.5%	-8.3%	7.6%	30.8%	-28.4%

Past performance is not a reliable indicator of future returns.

Source: Morningstar as at 28.02.2022, bid-bid, net income reinvested.

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Palaeontology

Armless fossils show how animals like snakes lost limbs

Christa Lesté-Lasserre

LESS than 100 million years after vertebrates first grew legs during the transition to land, some of their descendants had evolved to lose them again, fossils reveal. The discovery shows that land vertebrates first began to evolve a snake-like form at least 308 million years ago.

Arjan Mann at the Smithsonian National Museum of Natural History in Washington DC and his colleagues found two fossils of an ancient animal, both of which came from rocks in Illinois that are well-known among palaeontologists for preserving the remains of ancient land animals in fine detail.

The animal has been dubbed *Nagini mazonense*. It represents a new genus and species, within a group called the molgophids. *N. mazonense* may have grown to be about 10 centimetres long, and had a snake-like body with no forelimbs.

It also lacked the bony structures that support the attachment of forelimbs to the body, known as the pectoral girdle. However, *N. mazonense* did have a pair of small but fully formed back legs, with four toes on each foot.

Along with the nearly complete skeletons, which are around 308 million years old, there were also impressions of soft tissue, revealing that *N. mazonense* had a round snout and a long body with about 85 vertebrae and ribs. There were no signs of soft tissue in the area where forelimbs might be expected,

An artist's impression of *Nagini mazonense* (with blue stripes)

says Mann (*Nature Ecology & Evolution*, doi.org/hnkv).

"They're relying on body-based locomotion like sidewinding and not really relying on limb-propelled locomotion anymore," he says.

It is a fascinating discovery, says Rolf Zeller at the University of Basel in Switzerland. "Snake

"The discovery suggests that the ability to lose limbs is present in most vertebrates with legs"

embryos, such as pythons, still form hindlimb buds that disappear during development," he says. "The discovery of an ancient snake-like fossil lacking forelimbs but retaining hindlimbs is a fantastic find, because it reveals the existence of transitional forms before complete limb loss."

Modern snakes also lost their upper limbs and pectoral girdle first, about 170 million years ago, says Mann. They then lost their rear limbs about 100 million years ago.

But *N. mazonense* and other molgophids aren't

direct ancestors of modern snakes, says Mann. "They're sort of an early experimental lineage of reptiles."

The fact that the molgophids evolved to lose at least some of their limbs is an important discovery, because it shows that this ability is present in most vertebrates that have legs, he says.

Apart from snakes and some lizards, the only vertebrates without legs are a number of amphibians, including some salamanders and the worm-like caecilians. But it seems that other groups, such as mammals and birds, may have the capacity to evolve into legless forms – unless they have lost the associated genes, says Mann.

A related molgophid was discovered in the same rocks in Illinois in 2019, but in that case, the animal – called *Infernovenator steenae* – had four legs.

"[The rock site] is becoming a sort of a hotbed for looking at early reptile evolution and all the different body plans that were experimented on early on," says Mann. ■



HENRY SUTHERLAND SHARPE

Neurology

Chronic pain in Black people in US linked to gene expression

Jason Arunn Murugesu

BLACK people in the US have worse chronic pain than white people due in part to gene expression.

Edwin Aroke at the University of Alabama at Birmingham and his colleagues collected blood samples from 98 people – half were Black and half were non-Hispanic white, and their average age was 45. Half the group had chronic lower back pain, while the rest were pain-free.

Everyone with chronic pain was asked to report how bad their pain was and how much it affected their daily lives. Black participants had higher scores on both counts than their white counterparts.

The researchers analysed the participants' blood samples using genetic sequencing that identifies which sections of DNA have small

110

Signalling pathways with higher DNA methylation in Black people with pain

molecules called methyl groups attached. This methylation can happen for a variety of reasons, including ageing and chronic stress. This type of stress has previously been linked to racial discrimination, and can lead to changes in gene expression.

Earlier studies have shown that methylation may be linked to poorer health outcomes. In this study, there were 110 signalling pathways with significantly more methylated genes in Black people with chronic pain than in Black participants who were pain-free. These pathways have been tied to chronic pain. There were 31 pathways with more methylated genes in white people with chronic pain than in white participants without such pain (*Neurobiology of Pain*, doi.org/hm74).

DNA methylation is reversible, so interventions targeting racism may also reduce ethnic disparities in chronic pain, says Aroke. ■

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Medicine

Gene therapy treats skin condition

A gel applied to the skin replaces a faulty collagen gene in people with a genetic disease

Alice Klein

A RARE genetic skin condition has been corrected for the first time using a gene therapy that is applied to the skin.

About 1 in 800,000 children in the US are born with a severe condition called recessive dystrophic epidermolysis bullosa that makes their skin extremely fragile and prone to tearing and blistering.

"It is very painful," says Vincenzo Mascoli, 22, who travelled from Italy to the US to have the gene therapy. He had open wounds all over his body, including one covering his entire back that had been there since he was 2 years old. "Sometimes I also get blisters in my eyes and have to keep my eyes closed, and sometimes I get blisters in my throat that make it difficult to eat," he says.

Mascoli and other people with the condition have fragile skin because they have a faulty version of a collagen gene called *COL7A1*. That means their skin can't produce the collagen proteins needed to give it structure and strength.

Peter Marinkovich at Stanford University in California and his colleagues developed a way to insert normal *COL7A1* genes into the skin of such individuals so they can start producing collagen properly. The researchers did this by engineering herpes simplex virus to deliver the genes into skin cells. The virus is normally known as the cause of cold sores, but it was modified so it couldn't

Layers of skin can easily separate in people with epidermolysis bullosa

replicate or cause disease. "All it does is go into the cell and deliver the gene," says Marinkovich.

The gene therapy was then incorporated into a gel so it could be applied to the skin. It was tested in a late-stage clinical trial in the US involving 31 children and adults with recessive dystrophic epidermolysis bullosa, including Mascoli.

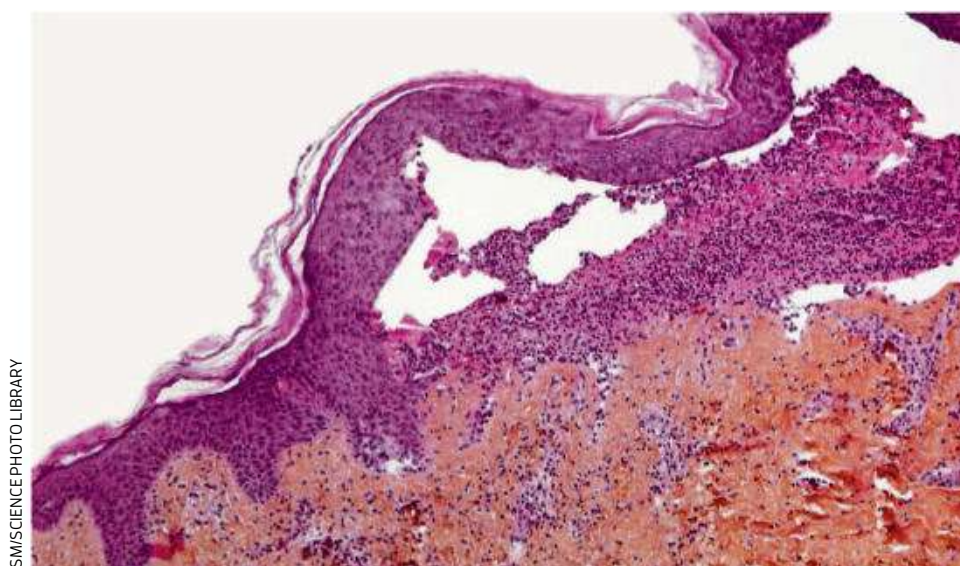
For each participant, the gene therapy gel was applied to one of their wounds and an inactive gel was put on another to compare the difference. The treatment was

repeated weekly until the wounds closed. After three months, 71 per cent of the wounds treated with the gene therapy had completely healed, compared with 20 per cent of those that had the inactive gel applied, and there were no serious side effects (*Nature Medicine*, doi.org/hnxx).

Mascoli's large back wound was treated with the gene therapy and it is now 95 per cent closed. "The gene therapy was very good for my back. Now, I can have a bath without it burning my skin," he says. "I hope I will be able to use it on the rest of my body."

Marinkovich has been trying to develop a treatment for epidermolysis bullosa for more than 25 years. He says it is "so nice to finally have something to offer this patient population. Up until now, they've had nothing, there have been no specific therapies."

A US company called Krystal Biotech has partnered with Marinkovich and his colleagues to develop the gene therapy and will apply in the next few months for approval to make it available to patients in the US. ■



ISM/SCIENCE PHOTO LIBRARY

Energy

UK gave cash back to fracking firms after shale gas ban

THE UK Treasury and the country's oil and gas regulator chose to give fracking companies a refund of £640,000 after the government banned shale gas exploration in England.

Exploratory fracking had already ground to a halt ahead of a moratorium imposed in November 2019, as firms struggled to operate without triggering minor earthquakes that alarmed local

residents and caused the work to be paused. However, Prime Minister Boris Johnson has recently asked for a fresh look at shale gas because of the energy price crisis, despite experts saying it would make no difference as production would take years to start.

When the ban came into force, firms that had paid oil and gas licensing fees for fracking were out of pocket, but a freedom of information (FoI) request by the website Drill or Drop? has revealed that the North Sea Transition Authority (NSTA), the UK's oil and gas industry regulator, chose to

approve applications for a waiver of the fees, with the blessing of the Treasury. The regulator wasn't obliged to approve the applications and pay back the money.

A spokesperson for the NSTA said: "Licensees can apply for a rental waiver to the NSTA. The NSTA considers these requests and not all waivers are granted. Any successful requests require HM Treasury confirmation."

£640k

Total returned to fracking firms by the UK government after shale gas ban

In total, £640,000 was paid back to companies for waivers granted for a period running from 1 April 2019 to 31 March 2021, according to the NSTA's response to the FoI request. The regulator doesn't say which firms received the money.

Greenpeace UK says now isn't the time to revive fracking. "The climate crisis and energy security concerns mean accelerating what is clean, cheap and deliverable, not indulging fantasies of hydrocarbon abundance stemming from a bygone era," says Doug Parr at the environmental group. ■

Adam Vaughan

Health

Male birth control pill is safe and effective in mice

Alex Wilkins

A NON-HORMONAL male contraceptive pill is 99 per cent effective at preventing pregnancy in mice with no observed side effects.

Despite many attempts at making an effective and safe male contraceptive, no treatment has passed human clinical trials. Most have been based on hormones, but non-hormonal contraceptives tend to have fewer side effects, says Md Abdullah al Noman at the University of Minnesota in Minneapolis.

"Safety is very important for birth control pills because people are not taking it for a disease, so they are less tolerant of side effects," says Noman.

He and his colleagues gave male mice a daily dose of a molecule called YCT529 over a four-week period, and found that their sperm count plummeted. Between four and six weeks after the mice stopped receiving the treatment, they could reproduce normally again with no observable side effects.

"When we went to even 100 times higher dose than the effective dose, the compound didn't show any toxicity," says Noman, who presented the results at the American Chemical Society Spring 2022 conference in San Diego, California, on 23 March.

The researchers have licensed their drug to a private company, YourChoice Therapeutics, which is aiming to carry out human trials in the US later this year.

While Noman and his team didn't observe any side effects in mice, this doesn't guarantee that the drug will be safe in humans, says Richard Anderson at the University of Edinburgh, UK.

"If you were developing a drug that's targeting a completely novel pathway, I think it would be appropriate to be cautious about safety when there isn't a track record in that field," he says. ■

Briefing

EU's latest plan to take on tech

The European Union's proposed law would force tech companies to open up to wider competition, says **Matthew Sparkes**

What does the new law say?

The final text of the proposed Digital Markets Act hasn't yet been released, but we already know it will be wide in scope. Tech companies will have to allow their services to connect with those of competitors, so that people using WhatsApp or Facebook Messenger, which are both owned by Meta, can chat seamlessly with those using Apple's iMessage.

People will also be given the right to remove pre-installed software from devices they buy, so you could get rid of Google software from a laptop sold by Google, or Apple's built-in apps from an iPhone.

Which firms will the law apply to?

Companies that meet a number of requirements: those with a value of €75 billion or over, those with at least 45 million monthly users and those that operate via an app, website or social network. This captures the likes of Meta, Google and Apple, but also smaller firms like Booking.com. Any company that breaks the law could be hit by fines of up to 10 per cent of its global turnover, and up to 20 per cent for repeated infringements.

When will these changes begin?

The draft act was provisionally agreed by the European Parliament on 24 March, but must be formally approved by the parliament and European Council. Then, there will be a buffer of 20 days before it becomes law, and the rules will start to apply six months later.

What will happen for people outside the EU?

Because of the complexity of offering varying services



LORENZO DI COLA/NURPHOTO/SHUTTERSTOCK

in different countries, the EU legislation is likely to be adopted worldwide by most companies, meaning that the benefits of more consumer choice won't be confined to Europe. This happened with the EU's General Data Protection Regulation, which is designed to protect consumers' data. Some countries that deal with the EU have adopted similar laws to streamline trade, while some companies decided to introduce a more stringent policy globally for the sake of simplicity.

Are there any downsides?

Making messaging services interoperable is a large engineering hurdle. Neil Brown

"I fear that those pushing for this don't understand the implications of what they are asking for"

at UK law firm decoded.legal believes it carries the risk of compromising the end-to-end encryption offered on services such as WhatsApp. "I fear that those pushing for this don't understand the implications of what they are going to compel service providers

WhatsApp and iMessage users can't communicate with each other

to do," he says. "Or, worse, that they do understand the implications and are pushing for it all the same."

Can't tech firms find a solution?

"In theory, you can still have end-to-end encryption if everyone is using absolutely compatible protocols, which they're probably not at the moment," says Keith Martin at Royal Holloway, University of London. "There's a lot of complexity around making the cryptography protocols broadly compatible. It's not something that anyone could do quickly. I would imagine for the people implementing these apps, it'll be a messy process."

But Martin says the law could ultimately boost security. "I think standardisation and scrutinisation is a good thing," he says. "I think possibly it would be a net gain for security if it meant that we had more high-profile, secure standards that everyone was using. There's an argument that that's a better world." ■

Astronomy

The struggle to define a planet sees some alien worlds kicked off the list

Alex Wilkins

WHAT is a planet? Astronomers still haven't found a definition that everyone can agree on – and the problem only gets harder when considering worlds outside our solar system, as the latest controversial attempt to define an exoplanet shows.

The International Astronomical Union (IAU), arbiter of all things cosmic, set out a final definition for planets in our solar system in 2006, famously demoting Pluto to a dwarf planet in the process. Its first requirement is that a planet is in orbit around the sun, which rules out all exoplanets.

An IAU definition of exoplanets set out in 2003 included any object below 13 times the mass of Jupiter, a cut-off chosen because objects of this mass with the same chemical composition as the sun start undergoing star-like fusion of deuterium, a form of hydrogen. At the other end of the scale, it excluded anything below the minimum size of a planet in our solar system, although this, in

turn, wasn't actually well-defined.

"Since that time, we have discovered many exoplanets and many different systems," says the IAU's Alain Lecavelier des Etangs – NASA puts the latest count at 5000. "The knowledge we have about these exoplanets is totally different from the knowledge we had in 2003."

To better conform to the new discoveries, the IAU's working group on exoplanets, a body of more than 400 astronomers, voted in 2018 for a definition that adds a new requirement: an exoplanet's mass must be less than 1/25th of the mass of the object it orbits.

This ratio is important because it implies something about how an object formed, says Beth Biller at the University of Edinburgh, UK. "If the mass ratio is fairly large, this is something that has formed in a disc around its star, like a planet, as opposed to something that forms more like a binary star," she says.

The new definition also decreed

that an exoplanet must be "clearing the neighbourhood" in its orbit, meaning that it has gravitationally removed other objects of similar size. This brings exoplanets in line with the definition of a planet within

"Several objects that are listed by NASA are no longer technically exoplanets"

our solar system. Although the exoplanet rules were voted on in 2018, details have only now come to light with a newly published explanation of the decision that has caught the attention of the wider astronomical community.

Mikko Tuomi at the University of Herefordshire, UK, called the new definition "horrible" in a tweet, saying it would be impossible for astronomers to detect whether an exoplanet has cleared its neighbourhood, while the mass-ratio requirement means free-floating "rogue planets" are

technically not planets because they don't orbit another body.

The mass ratio also kicks some existing exoplanets out of the club. "Several objects that are listed in the NASA Exoplanet Archive are no longer technically exoplanets," says David Kipping at Columbia University in New York, such as MOA-2010-BLG-073L b, which is 11 times the mass of Jupiter. "This is because they orbit very low mass stars, and so dividing that by 25 ends up cutting out [such] super-Jupiters."

Astronomers understand that definitions change as more information comes in, but it is in the marginal cases, where things can be considered a planet or a star, that questions often arise. "If you have a 13 Jupiter-mass object orbiting a star, and then you have a 12.5 Jupiter-mass object orbiting a star, and one is just slightly massive enough that it has deuterium fusion, then is that enough to call one a planet and one not?" says Biller. ■

Evolution

Ostrich necks act like a radiator to control head temperature

THE ostrich's long, flexible neck is an important way to stay cool in the heat and keep warm in cooler weather, and it may have evolved partly as an adaptation to wildly variable climatic conditions.

Large animals are vulnerable to rapid temperature changes because their big bodies tend to hold on to heat. To investigate how they evolve thermal tolerance, Erik Svensson at Lund University, Sweden, and his colleagues looked to the world's largest bird: the common ostrich (*Struthio camelus*).

From 2012 to 2017, they took nearly 5600 infrared photos of 794 ostriches at a research farm in Klein Karoo, South Africa. The team found that the neck was a "thermal window", emitting excess heat in hot conditions and retaining heat in the cold, stabilising the temperature of the head and brain.

The farm hosts three populations of the birds: South African "black" ostriches, Zimbabwean "blue" ostriches and the Kenyan "reds". Ostriches that evolved in what is now South Africa or Zimbabwe, regions with more climatic variability, were more efficient at shifting the temperature in their necks.

On hot days, female ostriches with a greater difference between



A male Kenyan "red" ostrich (*Struthio camelus massaicus*)

The researchers also suggest that, as the planet warms, ostrich necks could evolve to become even longer. Using pedigree data from ostriches on the farm, they confirmed that the neck radiator's efficiency is heritable.

Ben Smit at Rhodes University in South Africa says ostriches use evaporation from their open mouth and throat to lose heat. He wonders if the excess heat in the neck is mostly warm blood being shunted to the head, where evaporative cooling happens. ■

Jake Buehler

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Technology

Robot works out how to carefully peel a banana

Chris Stokel-Walker

A ROBOT trained by a machine-learning algorithm that imitates a human demonstrator can successfully peel a banana without smashing it to smithereens.

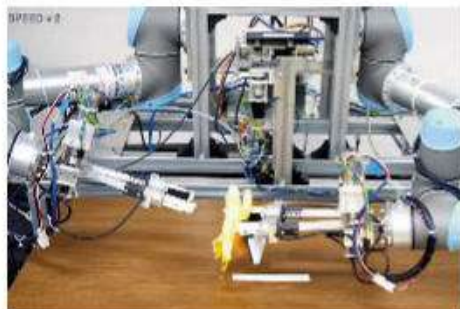
Handling soft fruit is a challenge for robots, which often lack the dexterity and nuanced touch to process items without destroying them. The uneven shape of fruit – which can vary significantly even with the same type of fruit – can also flummox the computer-vision algorithms that often act as the brains of such robots.

Heecheol Kim at the University of Tokyo and his colleagues have developed a machine-learning system that powers a robot (pictured below), which has two arms and hands that grasp between two “fingers”.

It was trained by having a human operating the robot peel hundreds of bananas, creating 811 minutes of demonstration data for the system to learn from. After training, the robot was able to successfully peel a banana 57 per cent of the time (arxiv.org/abs/2203.09749).

“What is really interesting in this case is that the process that a human uses has been carried over into the training of the robot system through the deep-imitation learning,” says Jonathan Aitken at the University of Sheffield, UK.

Aitken would like to see how the robot handles fruit that is more misshapen. The technology won’t simply be used for bananas, though: the goal is to train a system that can deal with general tasks that require fine motor skills. ■



Medicine

Drugs seem to help repair damaged mouse lungs

Carissa Wong



CT scan of human lungs (black) with damaged tissue (blue/green)

TWO existing drugs may help regenerate mouse lungs that have been damaged by cigarette smoke. The preliminary findings suggest the drugs might benefit people with chronic obstructive pulmonary disease, which currently has no cure.

COPD is the third leading cause of death worldwide after heart disease and stroke, and can result from smoking, air pollution or genetics. It involves an excessive immune response that irreversibly damages the lungs, leading to elevated mucus levels in them, shortness of breath and chest tightness.

“The problem with COPD at the moment is that we do not have a way of preventing the progression of disease and the decline in lung function. We only have ways to treat symptoms,” says Reinoud Gosens at the University of Groningen in the Netherlands.

COPD damages so-called epithelial progenitor cells that normally regenerate the lining of the lungs, meaning they cannot repair themselves. Previous efforts at treating this condition have mainly focused

on invasive cellular therapies such as stem cell implants, which provide a source of progenitor cells.

Gosens and his colleagues analysed data previously collected from the lung tissue of people with COPD and mice exposed to cigarette smoke, as well as data from healthy people and mice, to find out which

“The drugs identified are already used to treat other conditions, so we know that they are safe”

genes were more or less active in diseased tissues compared with healthy controls.

This allowed them to identify two proteins in epithelial progenitor cells that contributed to the disease and could be targeted with two existing drugs: iloprost, which is used to treat high blood pressure in lung arteries, and misoprostol, used to heal stomach ulcers.

To test these drugs, the team exposed mice to cigarette smoke for four months. Lung progenitor cells were then extracted from the animals

and grown in a gel for 14 days, in dishes that each contained one of the drugs, or control dishes with no drug.

“You take the progenitor cells and place them in a gel, then they form these mini-lung structures known as organoids,” says Gosens. By assessing how many organoids developed in the absence or presence of the drugs, the team found that both drugs appeared to fully restore the regenerative ability of the progenitor cells, which declined after exposure to the smoke.

The team also treated the mice with the drugs during a week of cigarette smoke exposure and found they had the same beneficial effect on subsequently extracted lung progenitor cells (*Science Advances*, doi.org/hm24).

“Compared to other drugs that can support lung regeneration in animals, the big benefit of the drugs we’ve identified is that they’re already used to treat other conditions, so we know that they are safe and they are similarly effective,” says Gosens.

“I’m really delighted to see people working on regenerative power using drugs in COPD,” says Rolf Ziesche at the Medical University of Vienna, Austria. “However, the model uses mice aged at about 20 human years, whereas typical COPD patients are around 50 and we know regenerative power slows with age. Better models are needed to really establish therapeutic potential.” ■

For more on regeneration, see page 35



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Time to green your home

With an energy crisis sending power bills soaring, using green tech to keep homes warm makes economic sense, finds **Adam Vaughan**

FOR the past few weeks, 22 million people across England, Scotland and Wales have had an unpleasant shock lurking in their inboxes and on their doormats, as their energy suppliers have laid out their future energy costs. For a home with typical energy consumption, annual bills will jump by 54 per cent to £1971 from 1 April under a regulated price cap.

The unprecedented increase was triggered by an energy crisis that started well before Russia's invasion of Ukraine, although this has pushed prices even higher. When the price cap moves again in October, analysts expect annual bills will hit anywhere between £2500 and up to £3000.

Emergency action will be needed to help the millions of people who are least able to pay. But for those with capital and cheap credit, a world with such high prices rewrites the financial calculations for the green home renovations that are considered essential for meeting the UK's climate targets. Energy experts say the attractiveness of measures

"The attraction of installing insulation, solar panels and heat pumps has fundamentally changed"

such as installing insulation, solar panels and heat pumps has fundamentally changed. "It has to massively change the calculus," says Rob Gross, director of the UK Energy Research Centre.

Solar panels are one technology back in the sun, after installation rates drastically slowed due to subsidy cuts six years ago. Solar power also got a boost in the spring statement on 23 March, which UK chancellor Rishi Sunak used to impose a 5-year-long cut in VAT on solar panels and energy efficiency products, from 5 per



IAN MASTERTON/ALAMY

cent to 0 per cent. That should cut solar installation costs by £1000, said Sunak.

Simon Evans at the website CarbonBrief calculates that the electricity bill savings of a 3-kilowatt peak solar photovoltaic system would currently pay back the upfront cost in 18 years. From April, that figure should drop to 11 years. By October, it should have dropped even further, to 7 years. The payback period will vary depending on homes and the solar panel system. Savings will also rise the more the household consumes rather than exports the solar electricity (Evans assumes 45 per cent self-consumption).

Self-consumption also makes more financial sense given that there is a growing gap between the amount people pay energy suppliers for electricity and what those suppliers pay households for exporting solar electricity. The cost of a unit of electricity is now capped at 21p per kilowatt hour, set to increase to 28p/kWh in April,

and it may reach as much as 45p/kWh in October. But the amount that energy supplier Octopus Energy is paying for solar exports increased at the end of January to just 7.5p/kWh, up on the 5.5p/kWh it paid before: a level that had stayed the same since 2019, when electricity prices were much lower. Still, Octopus is paying more than other energy suppliers: the joint second highest, E.ON and ScottishPower, pay 5.5p/kWh.

Jan Rosenow at the Regulatory Assistance Project says that the financial case is now clear-cut for solar panels, plus cavity wall insulation and loft insulation. "Loft and cavity insulation were already cost effective well before

The rising cost of power has made solar panels a more attractive option

the current situation and going forward will be even more effective," he says. Solid wall insulation of the kind required for older properties is more marginal from a cost perspective. It will typically cost £10,000 with energy bill savings of around £400 a year for a home on a gas boiler, according to modelling by David Adams at the UK Green Building Council (UKGBC). Nonetheless, now is a good time to consider solid wall insulation, he says, "in the context of net zero and getting off Russian gas".

Most home heating is provided by gas boilers today. As Marcus Shephard at the UK's Climate Change Committee wrote recently: "We cannot reach Net Zero if we continue to use gas for heat." For most homes using a gas boiler, the main low-carbon alternative is an air-source heat pump, which uses electricity to extract warmth from the air.

To date, these have been financially unattractive. An installation can cost £10,000 compared with £2500 for a gas boiler, and running costs are higher because most "green levies" – designed to support investment in renewables – are paid through electricity bills, not gas bills.

However, from April, Rosenow says they will be cheaper to run for the first time. That is because gas prices are increasing by 81 per cent in April versus 36 per cent for electricity, much of which also comes from renewables and nuclear. Octopus Energy, which hopes to become a major supplier of heat pumps, says a heat pump replacing a gas boiler would lower an annual energy bill by £8 from April. While that saving



The UK energy crisis has led to protests against fuel poverty



is marginal, Evans calculates the saving will be about £240 a year from October.

Crucially, April also sees the launch of the government's Boiler Upgrade Scheme, giving 30,000 homes a year a £5000 grant towards a heat pump. Octopus Energy claims it can match the cost of a gas boiler installation when the grant is factored in. Louise Hutchins at the UKGBC says the cost of heat pumps will fall too, as production and installs ramp up. Gas will also get more expensive and electricity cheaper, because the UK government has promised to shift the green levies onto gas bills over the next decade.

Of course, payback periods for different technologies will depend on how many years energy prices stay at current highs. Before Russia's invasion, analysts had expected wholesale energy prices to fall later this year, but that has been undone. High costs are now anticipated to continue well into 2023, but there is a huge uncertainty looking further out.

Few in society want such prices to persist. Nonetheless, Simon Cran-McGreehin at the Energy and Climate Intelligence Unit think tank believes "all bets are off" because geopolitics could be messy for years. "I think there's a need to start thinking about this in terms of an insurance policy," he says of green home measures.

However, while the financial calculations for those measures may have changed dramatically, it doesn't necessarily mean a wave of home energy retrofits will sweep the UK. Gross says all the "non-price barriers" remain, including lack of information, lack of access to capital, disruption and fear of builders. "This kind of idea that because the relative economics of something have changed, it will just kind of magically happen: all

Heat pumps are on the verge of becoming cheaper to run than gas boilers in the UK because of high energy prices

The horizontal axis shows efficiencies for heat pumps, measured as coefficient of performance (COP). The vertical axis is energy bill costs compared with using a gas boiler: a positive figure is more expensive, a negative one cheaper

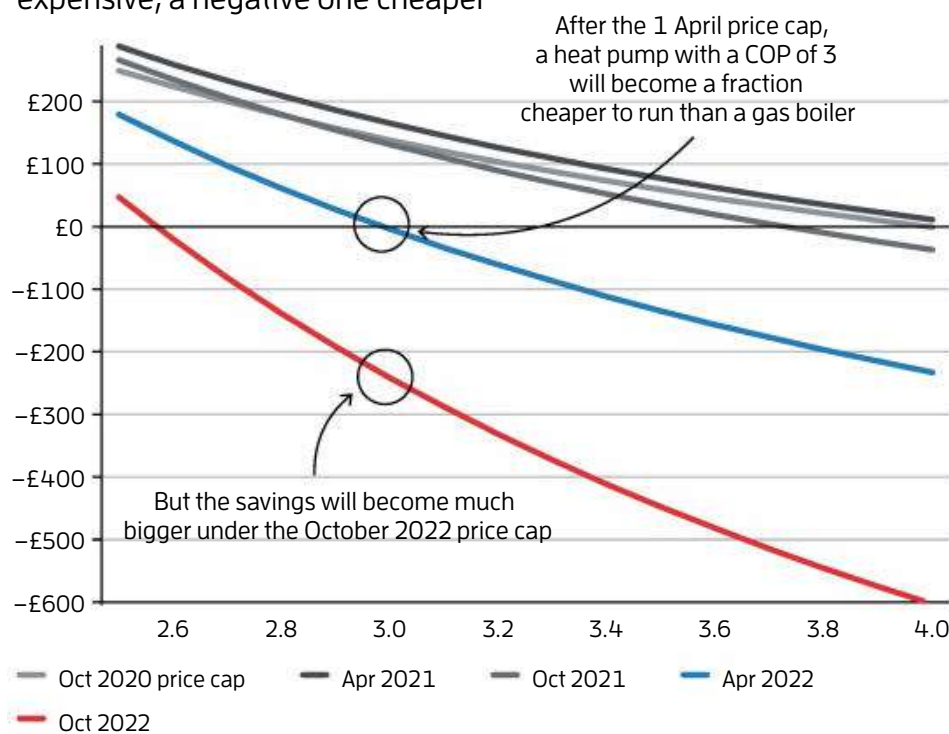


CHART: NEW SCIENTIST • SOURCE: CARBONBRIEF / INVESTEC

Energy price rises in October 2022 mean the payback period for solar panels would fall to less than a decade

The speed of payback depends on what energy suppliers charge for electricity and on what percentage of the panels' electricity a household consumes rather than exports. These figures factor in the VAT cut on solar panels announced in the spring statement

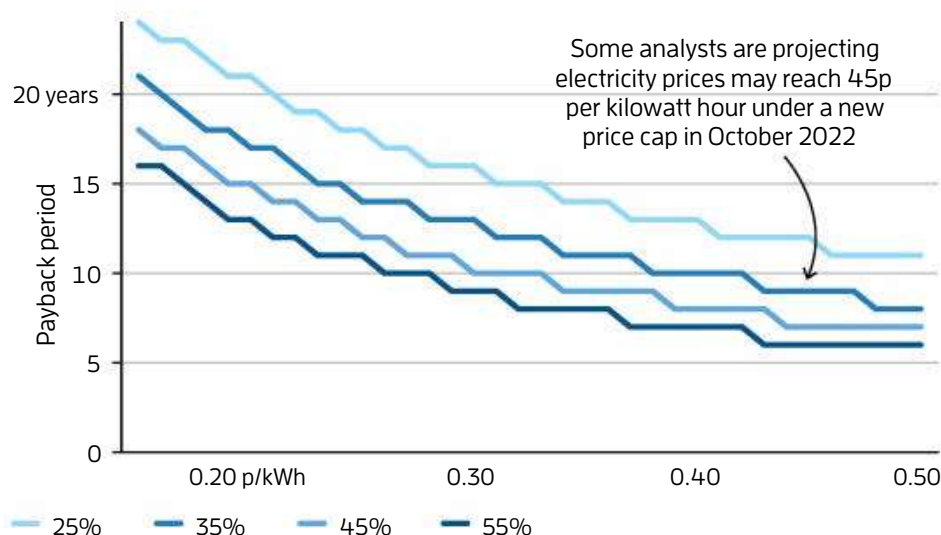


CHART: NEW SCIENTIST • SOURCE: CARBONBRIEF

the research evidence tells us that that's not true."

An absence of good advice is a big issue, says Rosenow. "A lot of what is online is out of date and based on old prices," he says. The Energy Saving Trust, which is intended to be the main impartial source of information for consumers, is still using existing energy prices even though the April price cap was announced in February. It says it is working to update its figures in line with post-April energy costs.

Overcoming hurdles is where the government has a role to play, says Gross. That could involve helping with upfront capital costs or loans. Previous government schemes – notably the 2012 to 2015 Green Deal and 2020 to 2021 Green Homes Grant – have been short-lived and poorly executed. "But that doesn't mean that we have to do it badly," says Gross.

Government support will also be important for the training and certification of installers, to assuage consumer fears of "cowboys", he adds. Another lever the government could pull is to make stamp duty when buying a property ramp up or down based on the home's energy performance, says Adams.

In the meantime, the terrible humanitarian situation in Ukraine could prove a more powerful spur for households than financial and environmental concerns. People have already taken to social media to post about how they have turned down their boiler flow temperatures and thermostats. Bigger steps, such as energy retrofits of the whole house, could be next. Rosenow says: "There's the emotional driver, where people feel, 'I really don't want to use gas any more: I want to reduce that for moral reasons, to support Ukraine.'" ■

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KIMBERLEY WILSON**
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TALK ONE

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Megan Rossi, dietitian, nutritionist and
founder of the Gut Health Doctor

TALK TWO

**FOOD, MOOD, BRAIN & BEHAVIOUR: THE
EVIDENCE LINKING FOOD AND NUTRIENTS TO
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Kimberley Wilson, chartered psychologist,
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JO-ANNE MCARTHUR/WE ANIMALS/NATUREPL

Infectious diseases

Human-to-animal infections more common than thought

WE often think of diseases passing from other animals to people, as in the case of covid-19, but they go the other way too and we seem to have vastly underestimated this spread.

Anna Fagre at Colorado State University and her team searched previously published research for all papers that describe human-to-animal disease transmission that didn't involve the new coronavirus.

The group found 97 reports, involving bacteria, viruses, fungi and parasites. Of these, 57 involved transmission to primates – probably because it is easier for pathogens to jump between humans and more closely related species (*Ecology Letters*, doi.org/hm3h).

Many of the transmission events involved zoo animals – for instance, a cheetah that caught a human flu strain – but they also involved wild

animals, such as mountain gorillas in Uganda (pictured) catching several bacterial infections. "I think there's a lot more transmission happening than we are currently picking up," says Fagre.

There were no confirmed cases of a disease crossing to an animal species and continuing to spread between individuals. But several wild skunk have been found to be infected with human influenza, which suggests that there may be ongoing transmission. And the virus that causes covid-19 is now spreading widely among white-tailed deer in North America.

There is a chance these diseases could harm the animals, but there is also the risk a pathogen mutates while in another host and becomes more dangerous for people, if it crosses back. **Clare Wilson**

Medicine

Tetanus trick tackles hard-to-treat cancer

PANCREATIC tumours have been drastically shrunk in mice using a strategy that allows the immune system to kill the cancer cells. The method may one day help to treat this deadly disease in people.

Most people with pancreatic cancer don't survive long because the cancer often spreads before symptoms arise and we lack effective treatments.

Many cancers can be treated using therapies that boost the cancer-fighting abilities of the immune system. However, these don't usually work for pancreatic cancer as it isn't easily detected by the immune system. The tumours also tend to be surrounded by cells that suppress immune activity.

To address this, Claudia Gravekamp at Albert Einstein College of Medicine in New York and her team used listeria bacteria, which are attracted to tumours, to

deliver an inactivated form of tetanus toxin to pancreatic cancer. Because most of us are vaccinated against tetanus, our immune systems detect it. So pancreatic cancer cells loaded with tetanus should be vulnerable to attack.

To test this, the researchers gave tetanus vaccines to young mice engineered to develop pancreatic cancer. When the animals had advanced cancer, the listeria bacteria were injected into them.

This successfully delivered tetanus to the tumours, making them visible to the immune system, which attacked the cancer. This was amplified by giving the mice a drug that stopped some of the cells around the tumours from suppressing immune activity.

This reduced the size of the pancreatic tumours and those that had spread to other parts of the body by over 80 per cent. It also improved the average survival time of the mice by 40 per cent (*Science Translational Medicine*, doi.org/hm6n). **Alice Klein**

Technology

A screen that you wear like a plaster

AN ELASTIC polymer that can glow like a filament in a light bulb could lead to flexible screens that are affordable, practical and robust.

These could form part of wearable computers that stick to our skin and do away with the need to carry a smartphone or laptop. But existing flexible displays have flaws: they either require high voltages; are lacking brightness; aren't bendy enough;

or are too fragile or too expensive.

Zhenan Bao at Stanford University in California and her team have created a light-emitting plastic material that can be stretched up to twice its original length without tearing. The polymer is up to twice as bright as smartphone screens. When an electrical charge is passed through the material, it causes photons to be emitted, creating red, green or blue light. A thin film can be stuck onto skin and doesn't rip when it flexes (*Nature*, doi.org/hm6j).

So far, the researchers have demonstrated small, static examples of the films in single colours. To be useful for devices, they will need to develop a larger version with discrete pixels and control technology to allow the image on the screen to change.

Harish Bhaskaran at the University of Oxford says a light-emitting polymer that is robust and cheap to manufacture could make new types of smart device practical. **Matthew Sparkes**



ZHANG AND LAIBAO GROUP RESEARCH LAB

Really brief

FRANS LEMMENS/LAMY



How boas constrict yet can still breathe

Taking a breath is difficult when you are using your rib cage to squeeze the life out of your prey. But the boa constrictor has come up with a solution: it can move the ribs lower down its long body to still pull air into its upper lungs while the ribs higher up are incapacitated (*Journal of Experimental Biology*, doi.org/hm55).

Sand supplies may run low by 2060

Our need for sand could soar 45 per cent over the next 40 years, and it isn't clear if supplies can meet such demand. A lot of sand is used to produce concrete. However, alternatives to concrete, such as the use of timber frames in buildings, could help avert a crisis (*Nature Sustainability*, doi.org/hnhf).

Tropical forests help hold down warming

Forests around the equator are more than just a carbon store, they also cool the air as water evaporates from leaves and triggers the build-up of clouds. Overall, they reduce global temperatures by 1°C (*Frontiers in Forests and Global Change*, DOI: 10.3389/ffgc.2022.756115).

Astrophysics

Odd waves within sun defy explanation

A STRANGE type of wave has been discovered that travels backwards through the plasma that makes up the sun. But possible mechanisms to explain these waves don't fit the data, so they remain a mystery.

Chris Hanson at New York University Abu Dhabi in the United Arab Emirates and his team found the phenomenon, called high-frequency retrograde vorticity waves, using decades of data from ground and space

telescopes. The waves comprise small eddies, or vortices, travelling around the sun in the opposite direction to its rotation.

However, the vortices move around the star three times faster than other, similar waves – more rapidly than can be explained by any models of plasma motion within the sun.

The researchers tested three possible explanations: that the waves were caused by magnetic fields within the sun; that they come from other ripples in the sun called gravity waves; or that they are due to compression of

plasma. None of these matches the data (*Nature Astronomy*, doi.org/hnhh).

“To find a set of waves that has no current explanation is... exciting and intriguing, because the challenge now remains to explain what they are,” says Hanson. “We are missing an ingredient in our understanding of the sun.”

The researchers couldn't think of any other plausible mechanisms, but they hope that more detailed modelling will be able to explain these strange waves in the future. **Leah Crane**

Farming



SIEGFRIED LAYDA/GETTY IMAGES

Genetic tweak boosts yields of two important food crops

TURNING off a particular gene in maize and rice could enhance yields by 10 per cent and 8 per cent respectively. By exploring similar genes in other cereal grains, global crop production could be boosted.

Maize (pictured) and rice are staple foods around the world, each with a distinct history of cultivation for large-scale consumption. It is believed that maize originated in Mexico, while rice came from China. Despite the independent evolution of these species, plant biologists have noted that they possess some very similar traits. This is known as convergent evolution.

To delve into these resemblances,

Xiaohong Yang at China Agricultural University in Beijing and her colleagues mapped the genomes of maize (*Zea mays* L. ssp. *mays*) and rice (*Oryza sativa*).

They found 490 pairs of genes that seemed to serve analogous functions in both grains. From these pairs, the researchers identified two genes – known as *KRN2* in maize and *OsKRN2* in rice – that affected their grain yield. By using CRISPR gene editing to switch off these genes, they could increase grain yield by 10 per cent in maize and 8 per cent in rice. These figures came from tests in farm fields (*Science*, doi.org/hm6d). **Chen Ly**

Wildlife

Genetic secrets of the vampire bats

VAMPIRE bats are missing several genes found in other bats, which may be related to their unique diet – they are the only mammals that feed exclusively on blood.

Living on blood is challenging because it is mostly composed of water and low in calories. To get enough energy, common vampire bats (*Desmodus rotundus*) have to ingest as much as 1.4 times their body weight in blood in each meal.

To find out more about how they adapted, Moritz Blumer at the Max Planck Institute of Molecular Cell Biology and Genetics in Germany and his team sequenced the common vampire bat genome and compared it with those of 26 other bat species.

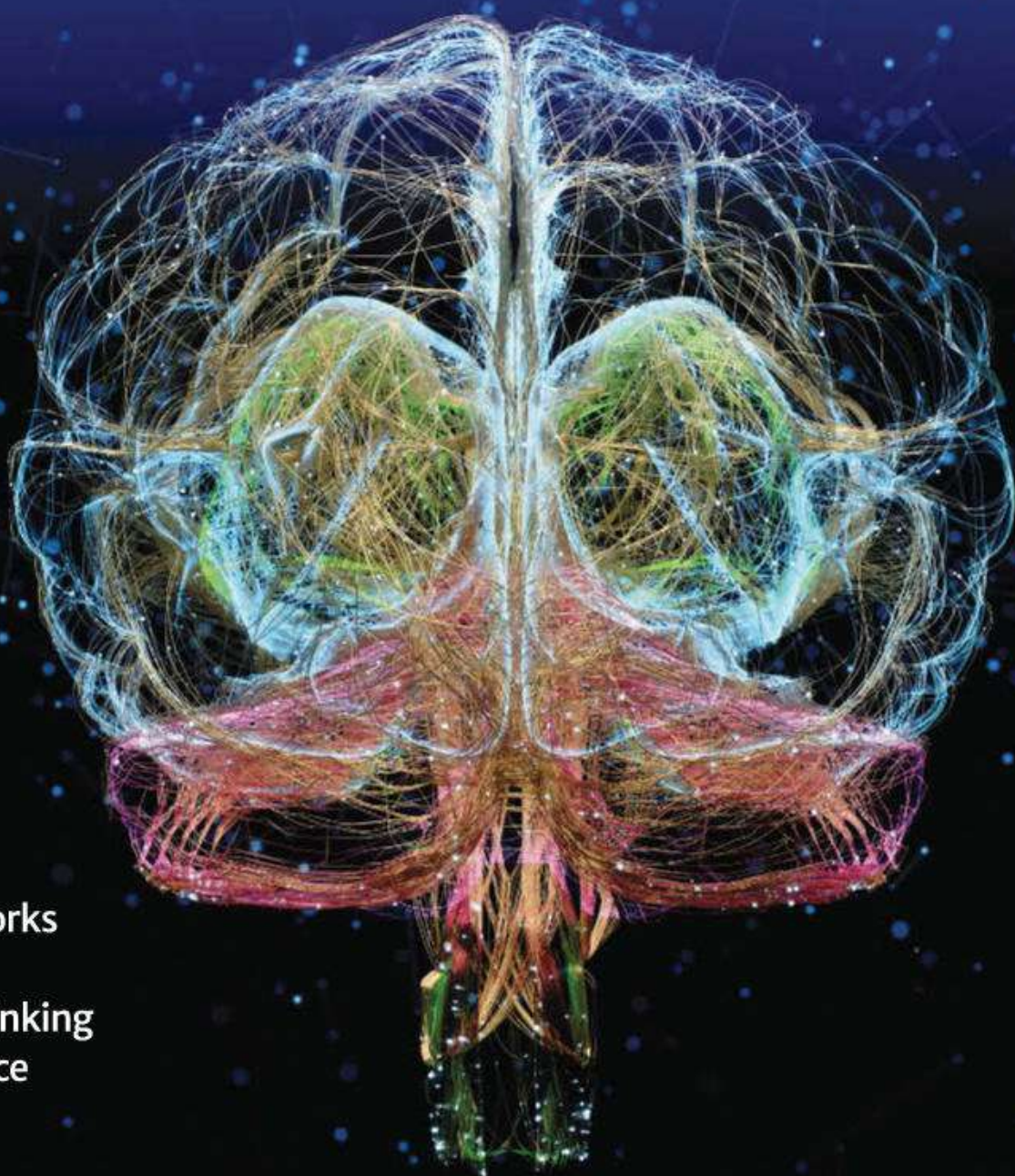
This showed that these vampire bats are missing 13 genes found in other bats. For example, three lost genes are linked to taste receptors that tell foods apart – redundant if you only feast on blood. Two more are usually involved in managing blood sugar levels, again not that necessary in a blood diet lacking carbohydrates. The loss of another gene seems to allow the bats to increase the amount of iron they can excrete, since their diet puts them at risk of excess iron in the body (*Science Advances*, doi.org/hnhj). **AK**

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Culture

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Comment

Zero doubts

Several countries are now abandoning their zero-covid approach, but the evidence shows it was the best route to take, says **Michael Marshall**

IT HAS been two years since the World Health Organization declared covid-19 a pandemic, and governments are still changing tack. One of the biggest shifts has been the abandonment of the “zero covid” strategy by countries like New Zealand and Vietnam, which are opening up and allowing the virus to spread.

As a result, it is tempting to think the approach was a mistake and that the strategy of nations like the UK has won out. But that is nonsense. Countries that followed the zero-covid playbook have done better on every measure, from death rates to economic growth. If more nations had implemented this approach, humanity would be in a better place. When the next pandemic emerges, governments should consider trying to eliminate it using zero-covid methods.

There is no single definition of a zero-covid strategy, but it generally means reducing the spread of the SARS-CoV-2 coronavirus as much as possible. This typically entails a rapid lockdown once the virus is detected in the community, followed by reopening once cases have fallen, combined with a robust system for testing, tracing chains of infection and supporting those who need to self-isolate.

The most obvious benefit is that far fewer people die. As of 18 March, New Zealand had seen 151 confirmed deaths from covid-19, or 0.003 per cent of its population – even though the



virus repeatedly snuck into the country. In contrast, more than 164,000 people are confirmed to have died in the UK, which is 0.24 per cent of the population.

Zero-covid policies also cause less economic harm. When the virus is barely present, people feel confident going out, so the economy can reopen more fully. There is an economic cost to the initial lockdown, but many nations that allowed the virus to spread have also had lockdowns to save their health systems and so paid the same costs – and their lockdowns were often longer. A 2021 study found there was greater

economic growth in zero-covid countries than in those that let the virus spread. The one big downside is that maintaining border controls hurt trade and tourism. But overall, zero-covid nations did better economically.

Although zero covid was a successful strategy for countries like New Zealand, they are now abandoning it. A key factor has been the evolution of the virus. The delta variant was far more transmissible than the original virus, and the newer omicron variant is more transmissible still. These new variants can only be halted by truly draconian

measures, so governments that previously banked on elimination have been forced to let the virus in.

If the target of zero covid is now being ditched, does that mean it was a failure? A crude answer would be: only if you think saving lives and preserving economic growth constitutes a misstep.

Let’s go further. Consider what would have happened if, in early 2020, every country able to had adopted a zero-covid policy. It is incontestable that the global death count would be far lower, fewer people would have long covid and the economic damage would have been reduced. The virus would still be spreading, but slowly, and rising rates of vaccination would control it further. Crucially, omicron probably wouldn’t have had the chance to evolve.

At the start of the pandemic, governments like the UK’s asserted that eliminating the virus was utterly impractical and so it was necessary to let it pass through the population in a “controlled” manner. Two years on, we know that was wrong.

When the next pandemic emerges – as it will – governments should remember zero covid, and work together to eliminate the new threat if they feasibly can. Coordinated international action is hard, but we must learn to do it. ■



Michael Marshall is a science writer in Devon, UK, and author of *The Genesis Quest*

This changes everything

An idea with wings Thousands of us are glued to the online dramas of two peregrines, but the Cal Falcons webcam is just the start of what tech can do for bird studies, writes **Annalee Newitz**



Annalee Newitz is a science journalist and author. Their latest novel is *The Future of Another Timeline* and they are the co-host of the Hugo-nominated podcast *Our Opinions Are Correct*. You can follow them @annaleen and their website is techsploitation.com

Annalee's week

What I'm reading

How Our Days Became Numbered: Risk and the rise of the statistical individual by Dan Bouk

What I'm watching

Our Flag Means Death, a delightful comedy series about the not-so-dread pirate Stede Bonnet.

What I'm working on

A podcast episode about animal communication.

This column appears monthly. Up next week: Beronda Montgomery

A FEW weeks after officials in California issued the first stay-at-home orders of the pandemic, back in 2020, something amazing happened on the internet. Well, not on the internet exactly – it happened in a gravel box high up on a bell tower, while thousands of us tuned in by webcam to see two peregrine falcons snuggling their freshly hatched chicks. Over the next few months, we watched the Cal Falcons webcam as the tiny chicks grew into fierce adults. The sight was a balm. It was a scientific wonder as well.

Peregrines were locally extinct in many parts of North America 50 years ago, and endangered throughout the world, after the pesticide DDT nearly wiped them out. Now, thanks to decades of conservation efforts, the raptors are making homes in our cities, even in a noisy bell tower in the middle of the University of California, Berkeley, campus.

“People have contacted me and said watching is our one solace during these huge events,” says Lynn Schofield, a founder of the Cal Falcons project and a biologist at the Institute for Bird Populations in Petaluma, California. She and her husband Sean Peterson, an environmental researcher at Syracuse University in New York, worked with a team to build the birds’ nest in 2017. Then, in 2019, they crowdfunded the Cal Falcons webcam to educate the public about urban wildlife. The birds have returned every year to rear a new clutch of young.

The pair named the falcons Annie and Grinnell, and post videos from their lives, with scientific explanations for their generally adorable, often bloodthirsty, behaviour. They also host livestreams to take audience questions at key

moments in the birds’ lives.

Right before the 2022 egg-laying season, which lasts roughly from March to May, Annie and Grinnell’s lives suddenly became a soap opera. More peregrines were encroaching on their territory and Grinnell was attacked by the interlopers. With an injured wing, foot and beak, he fell to the ground and was discovered by nature-lovers, who brought him to a local wildlife hospital. It took a month for him to recover, and while he was gone, Annie began to court other males.

All of us watching the Cal Falcons cam were riveted.

“In just 50 years, the nearly extinct peregrine has become populous enough to spawn soap operas”

Would Annie wait long enough for Grinnell’s triumphant return? Would she even want him after his defeat? Although female peregrines are twice as large as males, and far more dangerous, they still need strong partners.

At last, Grinnell was well enough to return, and Annie seemed to accept him. They bowed their heads to each other and chirruped (classic courtship behaviour) and the webcam even captured them mating. But then Annie abruptly disappeared for more than a week – unheard of during laying season. Grinnell began courting a new young female, and Schofield and Peterson sadly informed the Cal Falcons community that they assumed Annie had died or left the territory.

The very next day, Annie reappeared at the nest, much to the watchers’ delight. Schofield and Peterson held a livestream

to explain what was happening. Over the past couple of weeks, Annie has been in the nest a lot, and it looks as if she is back to stay.

The webcam is just the beginning in terms of what technology can do for the study of birds. Schofield says “most birds lead a double life”, nesting for a few months, and then migrating across huge distances. That is why she is working with groups like Motus, a non-profit organisation that uses radio telemetry to track birds in motion. Researchers attach tiny radio transmitters to animals, and then rely on a network of scientists and amateurs to set up receivers that pick up signals from the tagged creatures (see page 43 for more on tracking animals). The result is a map of where birds like Annie go when they aren’t rearing babies.

“We need to know where the wildlife is if we’re going to conserve it,” says Schofield. “That’s the constant difficulty of studying birds. They exist on continental scales.” Eventually, she says, we will be able to use machine learning to analyse the radio signals for common bird behaviours like hunting and nesting.

These days, most of Schofield’s research focuses on how wildlife is affected by climate change and fire – pretty grim subjects. That is why the webcam is so important: it is evidence that conservation research can pay off. In just 50 years, the nearly extinct peregrine has become populous enough to spawn soap operas. Plus, Annie and Grinnell’s fans have formed a brigade of citizen conservationists, including children who may become the next generation of environmental scientists. The Cal Falcons cam, says Schofield, “makes a big difference – it reminds me that all of this work is worthwhile”. ■

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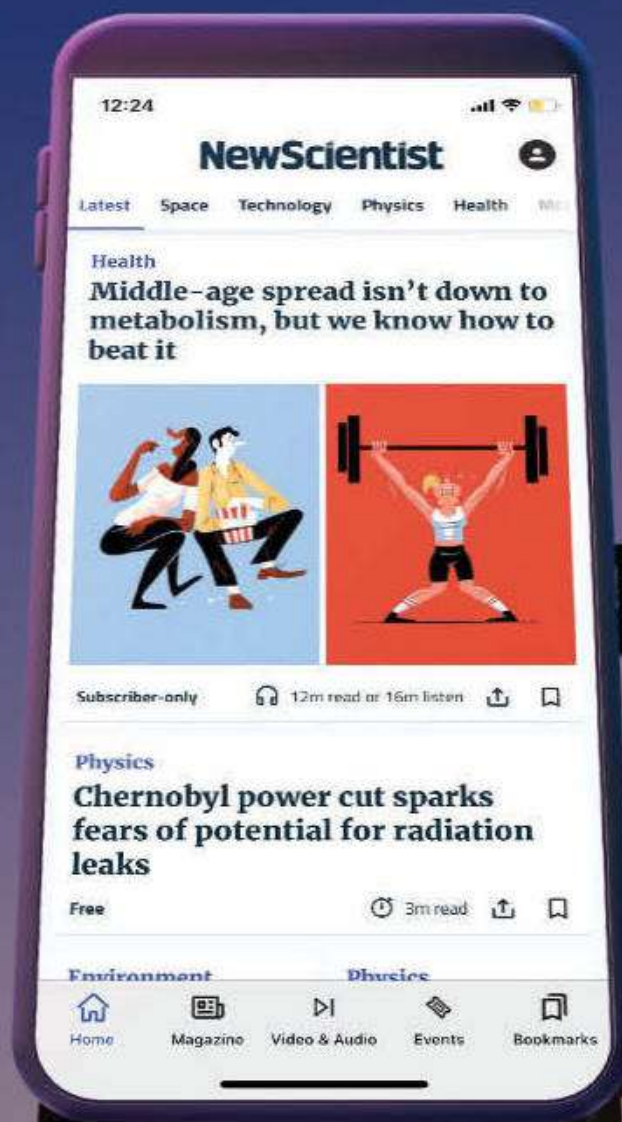
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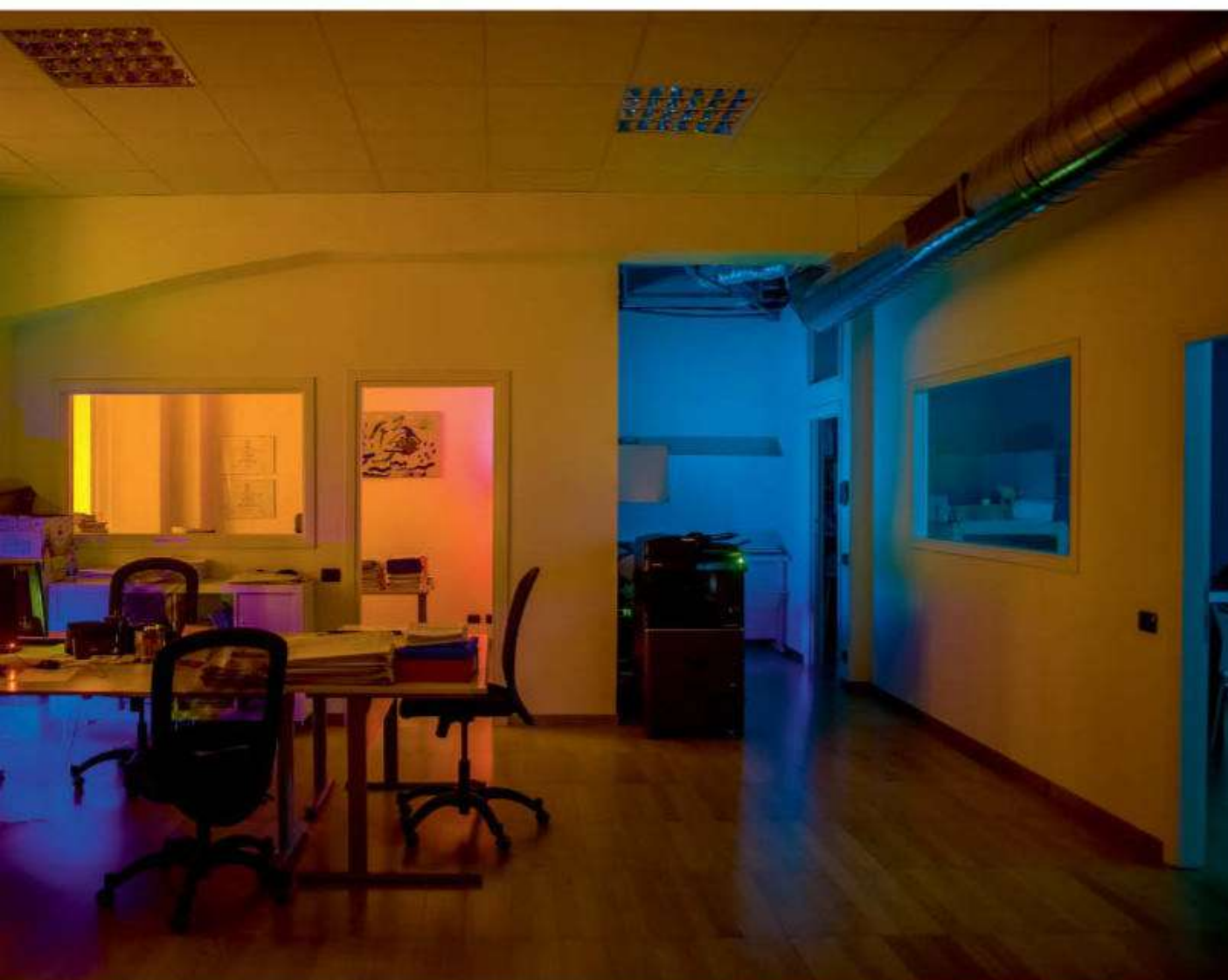
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Vampire power



Photographer **Alessio Perboni**

THESE are night-time scenes as you have never seen them before. Using long-exposure techniques and only the illumination from LEDs on household and office devices on standby, such as TVs and computer monitors, photographer Alessio Perboni, based in Milan, Italy, casts the everyday in a new light.

These images are part of a photo project that is under development by Perboni called Stand-by. The Wasted Month, which will highlight the energetic cost of keeping devices on standby instead of switching them off completely.

There are many estimates of the amount of energy used during standby, sometimes referred to as “vampire power”. One study of around 1300 homes in the European Union, for example, found that standby energy use amounted to about 7 per cent of a household’s total energy consumption.

With energy prices on the rise in many parts of the world, Perboni says he wanted to highlight the importance of this “seemingly invisible and negligible” problem. In fact, as the name of his project points out, the standby energy wasted in a typical home in a higher-income country in a year could power that same building for about a month. ■

Gege Li

Editor's pick

Russia's nuclear threats just don't ring true

5 March, p 7

From Florence Gaub,
European Union Institute for
Security Studies, Paris, France

Further to your report on concerns over Russia's nuclear weapons status, the "special regime of combat duty" that the country has elevated its nuclear readiness to is meaningless. It isn't an official category in Russia's nuclear level classification, meaning it was created to cause upset more than anything else.

The idea that it is now at level 2 of 4 is simply unfounded and is Russian propaganda. This is confirmed further by the fact that Russia hasn't actually increased anything when it comes to nuclear weapons, i.e. it hasn't loaded missiles, increased activity, etc.

More importantly, anyone who puts the odds of a nuclear strike at 20 per cent is wrong. Probabilities can't be established in the absence of data. We have an extremely small sample of nuclear strikes and not enough data to understand why and when nuclear weapons would be used. This doesn't mean the probability is zero, it just means we can't make a statement of this kind.

The US elevated its nuclear level (its actual nuclear level, not some made-up level for public consumption) several times in non-nuclear crises, such as the 9/11 terrorist attacks, the first Gulf war and the Yom Kippur war. Again, this doesn't mean it is harmless, but it does show that this isn't extremely unusual.

Plenty of other hints that we are in a simulation

Letters, 19 February

From Alec Cawley,
Newbury, Berkshire, UK

Alec Williams suggests we look for pixelation to see if our universe is a simulation. That relies on the idea that the simulator's

technology is similar to our own.

Even if it isn't, we can see shortcuts being made by the simulator now. There is quantum indeterminacy, where the simulator stops tracking everything exactly and instead throws a weighted random number. And, at the other end of the scale, the cosmic microwave background forms a tidy edge to the simulated universe.

I am sure other simulation tricks are being performed, like simulating things that aren't easily seen at lower resolution. Those distant galaxies are probably only approximated.

Maths errors were great for keeping us on track

12 March, p 28

From Arthur Barnett, London, UK

On the benefits of deliberate errors: 50 years ago, as a maths undergraduate, a small group of us used to record the errors in lecture notes. The lecturers would complain that we didn't point them out, but we found keeping them useful in understanding and revision. The errors provided useful flags in the mathematical arguments that avoided our attention drifting.

From Bryn Glover, Kirkby
Malzeard, North Yorkshire, UK
Could David Robson's notion of "fruitful" errors be the real explanation behind British comedian Les Dawson's unique piano performances?

The time for impartiality on Earth's future is over

26 February, p 26

From Andrew Marston,
Flushing, Cornwall, UK
My household is particularly

keen on getting the real science behind climate change and the biodiversity emergency. Thanks for continuing to supply it in articles such as "Drowning in a sea of plastic". In it, Graham Lawton offered a balanced analysis – of hope tempered with political realism – but I would love to have some tips on possible actions at the end of such pieces. Who can we write to in order to try to tip the scales in favour of a meaningful plastics treaty, for example?

I don't think it is enough to simply observe as if impartial any more: scientific knowledge brings an obligation to act upon it when the evidence is as clear as it is and yet still being ignored. Please help us, your readers, feel we can make our voices heard.

Baby boomer theory doesn't add up for me

5 March, p 21

From Duncan Cameron,
Brighton, UK

Your article on UK baby boomers being the unhappiest generation was interesting, but I don't buy the belief that the higher birth rate during the baby boomer generation from 1946 to 1964 is relevant. The researchers' analysis found that cohort size was the biggest predictor of happiness. The article also says that "snagging the partner they wanted might also have been harder due to greater competition".

On the assumption that the proportion of eligible mates in a population remains the same regardless of any change in cohort size, simple logic suggests that the chances of meeting a suitable mate must remain the same regardless of cohort growth.

In fact, the revolution in sexual behaviour that occurred

in the 1960s and 70s meant it became much easier for baby boomers to find partners.

The problem with some tree-planting schemes

5 March, p 27

From Pamela Manfield,
Monmouth, UK

I agree with Jingjing Liang's points on the shortcomings of current forestry management in a world where tree planting is seen as a climate solution. These problems can be seen in Europe.

On a recent trip to Sweden, I discovered that the government is encouraging felling of thousands of old trees in the far north. New trees will be planted to suck up carbon, but reindeer rely on lichen in winter, which only grows on mature trees. Without lichen, the reindeer will starve and their Sami herders' way of life will disappear.

In Wales, big companies are buying farms to plant trees to offset their carbon footprints. But again, these trees will take a long time to grow. More importantly, small farms are vital to the economy and communities of rural Wales. If the farms disappear, so will the people and villages that benefit from them. We seem to be too eager to take up green solutions without considering the drawbacks of many of them.

Message to Kirk: No need to time-travel to get whales

12 March, p 35

From Robert Checchio,
Dunellen, New Jersey, US

That AIs may allow us to converse with whales, an idea raised in the book *How to Speak Whale*, would have been invaluable to Captain Kirk in the film *Star Trek IV: The Voyage Home*, in which the inability to respond to an alien probe trying to communicate with whales threatens Earth. Kirk had to time-travel back to the 20th century to get some humpback whales. These then responded to the probe, saving the day. ■



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Mercy Nanjala, Kenya



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Down on the farm

A dairy cow's-eye view on the world raises uncomfortable questions about the way we treat animals, finds **Elle Hunt**



Through Luna the dairy cow, we see the reality of life lived on human terms

clear that Luna is well cared for, even loved. But the life of a dairy cow is, by definition, one that is punctured with sudden violence. Though *Cow* may not depict the industrial-scale horrors of animal production, Arnold doesn't shy away from depicting the indignities and intrusions that feature in a dairy cow's world. An early scene of calves being dehorned with a cauterising iron reportedly had critics at the Sundance film festival covering their eyes.

The end, when it comes, manages to be at once inevitable and shocking – the harshest possible awakening from the dreamlike state viewers have been lulled into. It encapsulates the film's understated political point: that, from beginning to end, this is a life led entirely on humanity's terms, for the production of milk and meat. Luna may not suffer more than is essential to the existence of a dairy cow, but is that a price we are willing to accept?

In honouring the sacrifice of one farm animal, Arnold quietly but insistently invokes the spectre of far more – many of which aren't treated with the same dignity as Luna, even if we choose to remain ignorant of the details.

Empathetic and often unexpectedly moving, *Cow* may not instantly turn you vegan, as more aggressive accounts of animal production might – but you will never see its subject in the same way again. Equally, having gently led us to assume the bovine gaze, what may be most unsettling is how we see ourselves. ■

Elle Hunt is a freelance writer based in Norfolk, UK



Film
Cow
Andrea Arnold
MUBI and Apple TV+

MOST documentaries chronicle exceptional lives that anyone would be curious about, or highly ordinary ones that warrant a second look. Andrea Arnold's new film does both, providing an immersive look into the world of a dairy cow.

Arnold is the celebrated director of projects as diverse as *Red Road* and *Fish Tank*, which explore working-class Britain; the Shia LaBeouf epic *American Honey*; a 2011 adaptation of *Wuthering Heights*; and episodes of *Transparent* and *Big Little Lies*. In *Cow*, her fifth feature and first documentary, Arnold turns her trademark unflinching gaze on a subject that is both familiar and entirely other: a cow named Luna on a cattle farm in the English countryside.

Six years in the making, the BAFTA-nominated *Cow* follows Luna in her day-to-day life, from grazing and mating to birthing and milking. It is about as immersive and visceral a depiction of a non-human being as one can imagine, with Arnold filming from Luna's perspective as much as possible and using zero narration.

For many viewers, the first surprise may be the immediate, easy charisma of her subject: in an early scene, Luna holds the camera's gaze, mooing insistently, in such a way that it leaves the audience in no doubt about her curiosity and appraising intelligence. Likewise, shots of her caring for her just-born calf and taking obvious pleasure from an open field suggest a multifaceted mind, which is portrayed clearly and without sentimentality.

For an essentially quiet film, sound is used to great effect in *Cow*. Mournful pop songs by Billie Eilish and others are piped into the milking shed, adding pathos to the

scenes of Luna's everyday life, while snatches of chatter from her largely faceless farmers lend them structure. The emotion we come to feel for Luna, our investment in her well-being, is organic and earned.

The only point where Arnold relaxes her commitment to realism is a late-night mating sequence, set to R&B pop music and with spliced-in

“Luna may not suffer more than is essential for a dairy cow, but is that a price we are willing to accept?”

fireworks, a moment that concludes with some post-coital cuddling. The surreal comedy of the scene excuses any charge of anthropomorphism, as does the sequence where Luna is being milked on Christmas morning by a farmer wearing a Santa hat, set to the sound of *Fairytale of New York*.

This is no hard-bitten slaughterhouse exposé: it is

Spare parts on demand

The mysterious process of regeneration can help us understand life in all its complex glory, finds **Simon Ings**



Book

What Is Regeneration?

Jane Maienschein and
Kate MacCord

University of Chicago Press
(out 6 April)

SOME animals are able to grow an entire new body from tiny parts. Crabs and lobsters can regenerate lost tentacles and claws. Hydras and some worms can regrow their heads. We humans can replace our skin, hair, fingernails and even our liver.

Regeneration is such a peculiar ability that, even in science, it is surprisingly under-researched. As a result, there is much we still don't know. *What Is Regeneration?* is a collaborative effort between Jane Maienschein and Kate MacCord, both at the Marine Biological Laboratory in Woods Hole, Massachusetts, to fill some of the gaps. Together, they explore why regeneration occurs when it does, why it doesn't always happen and what the process can tell us about the grander mysteries of birth, death and development.

It turns out to be a seemingly simple phenomena that, on closer inspection, becomes far more complicated. For instance, are we thinking only about regeneration of structure, about regeneration of function or both? Is the regeneration of the gut flora in your intestines after a course of antibiotics or the regeneration of woodland after a forest fire at all similar to regrowing a body part?

To try to pin it down, the authors begin with a history of the study of the subject, starting with Aristotle and ending with Magdalena Zernicka-Goetz's ongoing research

on cellular signalling. Their account pivots on the work of Thomas Hunt Morgan (better known as a pioneer of chromosomal genetics) and, in particular, his 1901 book *Regeneration*. Morgan, more than anyone before or since, attempted to establish clear boundaries around the phenomenon, and the terminology he came up with remains useful.

He identified three kinds of regeneration. The first two are restorative regeneration, which occurs in response to injury, and physiological regeneration, which describes replacement, as when an elk moults its antlers and new ones grow in their place. The third, morphallaxis, refers to more extreme cases, such as when a hydra, cut into pieces, reorganises itself into a new hydra without going through the normal processes of cell division.

The key to this categorisation is that the mechanisms of regeneration aren't, as the authors put it, "a special response to changing environmental conditions but, rather, an internal normal process of growth and development".

So here is the problem: if the mechanisms of regeneration can't be distinguished from

those of growth and development, what is to stop everything ceaselessly regenerating? What dictates the process of regrowth and why does it happen only in some tissues, in some species and only some of the time?

Maienschein and MacCord argue that, to fully understand this, we need to see regeneration as a window into the world of biology in general, and the complex feedback loops that decide what grows, divides and dies, where and when.

Far from being an interesting curio, then, studying regeneration can tell us much about life in general, from a cellular level right up to the level of ecosystems, and inform everything from regenerative therapies using stem cells to ecosystem protection and recovery.

Seen through this lens, regeneration is a far bigger subject than it might at first seem, and Maienschein and MacCord take fewer than 200 pages to anatomise the complexities and ambiguities that their simple question throws up. It is to their credit that they mostly focus on the big picture and don't make the biology any more complex than it needs to be. ■

Simon Ings is a writer based in London



KARENBLACK/GETTY IMAGES



Watch

Apollo 10 ½ sees Richard Linklater use the hallucinatory animation style of his *A Scanner Darkly* to tell the fantastical tale of a young space fan living in Houston, Texas, in 1969, when anything felt possible. Via Netflix.



Visit

Requiem features an urn full of dust gathered by artist Katie Paterson from meteorites, rocks, corals and other detritus. From 9 April, it will be the focal point of an exhibition at the Ingleby Gallery in Edinburgh, UK, that explores our planet's past and future.



Read

Power in the Wild, by behavioural ecologist Lee Alan Dugatkin, reveals the realpolitik behind the lives of sweet-looking creatures from meerkats to field mice, as he examines the eternal struggle for dominance in nature.

Is the regeneration of a forest after fire fundamentally the same as an animal regrowing a body part?

Lost at sea?

The search for one enigmatic whale drives home the plight of them all, finds **Katie Smith-Wong**



Film

The Loneliest Whale: The Search for 52

Joshua Zeman

Digital download from 4 April

IN 1989, the Woods Hole Oceanographic Institution in Massachusetts detected an unknown sonic presence at 52 hertz. It was initially thought to be from a submarine, but marine biologist William Watkins later determined that it was the sonar signature of a whale, which he gave the nickname “52”.

It is an unusually high frequency for whale vocalisations, and Watkins was intrigued enough to search for 52 until his death in 2004. But despite picking up 52’s call every year, Watkins never found the mysterious whale.

In *The Loneliest Whale: The Search for 52*, US film-maker Joshua Zeman picks up the search where Watkins left off, and sets out to find a whale that has since taken on almost mythical proportions.

Why 52 calls at this frequency is also a mystery – the whale’s species hasn’t been confirmed, and it is possible that it is the only one of its kind in the ocean. The one thing we do know is that 52 is almost certainly a he: male whales do the singing.

The reason for 52’s presumed loneliness has nothing to do with the fact that he has always been detected swimming alone. Instead, it is because the unique frequency of his call means that other whales can’t understand to respond. With 52’s unique call as the only lead, Zeman launches a seven-day search mission with bioacoustics specialist John Hildebrand and research biologist John Calambokidis.



COURTESY OF BLEECKER STREET

Looking for one whale in the vast, deep ocean was never going to be easy

They begin in the waters off California, at the Port of Los Angeles – the busiest container port in the western hemisphere. Their initial hopes aren’t high: the Pacific Ocean is deep and wide and the chances of finding 52 seem roughly the same as those of 52 finding a mate.

Zeman’s documentary has a strong sense of exploration and ambition: he believes he can locate 52, who has become the Moby Dick to Zeman’s Ahab. Although there is an underlying sense of excitement as to whether 52 can finally be found, there is a human aspect to the search and a personal story behind Zeman’s fascination.

In our increasingly connected world where contact and interaction is only the click of a button away, the fact that so many people still report feeling lonely makes it easy to identify with 52’s situation. There is something deeply affecting about a creature as intelligent and social as we know whales to be, swimming

the vast ocean, year after year, never having any proper contact with another of its kind.

This, combined with a growing awareness of the harm that human activity has caused whales, has made 52 something of a focal point for whale conservation, with articles, poems and even a song by the K-pop band BTS about his plight.

Yet this is a story that goes deeper than just one whale. Whale populations are still under threat from hunting, pollution, climate

“There’s something deeply affecting about a social animal never having contact with another of its kind”

change and collisions with ships. Even if they avoid these perils, the noise of shipping can drown out a whale’s calls, regardless of the frequency it may use. Arguably, Zeman’s quest says more about our collective guilt about this state of affairs than it does about our desire to solve the scientific mysteries surrounding 52.

Finding him is never a foregone

conclusion. In fact, as 52 has never been seen or even definitively proven to exist, some within the scientific community are sceptical there is even a 52 to find.

Zeman’s attempt to create a sense of thrill and adventure as he embarks on his quest is hit-and-miss. Exciting footage of the search is punctuated with evocative images of the oceans, which makes the documentary’s tone feel inconsistent. At times, there isn’t enough to elevate the film above being a group of people spending time in a boat. At least not until the closing moments, when it appears that the team’s efforts may not have been in vain.

Overall, *The Loneliest Whale: The Search for 52* offers a moving insight into a legendary whale and Zeman’s curiosity is infectious. Frustratingly, though, there isn’t enough discussion and explanation of the science behind whale communication, which leaves viewers, much like Zeman, wondering if they might have missed something important along the way. ■

Katie Smith-Wong is a freelance writer based in London



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Consciousness in the cosmos

To make sense of time and quantum reality, physicists are radically rethinking the relationship between matter and mind, finds **Thomas Lewton**

A WALK in the woods. Every shade of green. A fleck of rain. The sensations and thoughts bound in every moment of experience feel central to our existence. But physics, which aims to describe the universe and everything in it, says nothing about your inner world. Our descriptions of the wavelengths of light as they reflect off leaves capture something – but not what it is like to be deep in the woods.

It can seem as if there is an insurmountable gap between our subjective experience of the world and our attempts to objectively describe it. And yet our brains are made of matter – so, you might think, the states of mind they generate must be explicable in terms of states of matter. The question is: how? And if we can't explain consciousness in physical terms, how do we find a place for it in an all-embracing view of the universe?

"There is no question in science more difficult and confusing," says Lee Smolin, a theoretical physicist at the Perimeter Institute for Theoretical Physics in Waterloo, Canada.

It is also one that he and others are addressing with renewed vigour, convinced that we will never make sense of the universe's mysteries –

things like how reality emerges from the fog of the quantum world and what the passage of time truly signifies – unless we reimagine the relationship between matter and mind.

Their ideas amount to an audacious attempt to describe the universe from the inside out, rather than the other way around, and they might just force us to abandon long-cherished assumptions about what everything is ultimately made of.

Modern physics was founded on the separation of mind and matter. That goes back to Galileo Galilei, whose big idea, some four centuries ago, was to boil the world down to the interactions of moving objects that could be described by mathematical laws. Our senses, meanwhile, lived in the human soul – distinct, though still important. "Galileo said 'don't worry about consciousness for the moment, just focus on what you can capture in mathematics,'" says Philip Goff, a philosopher at Durham University, UK.

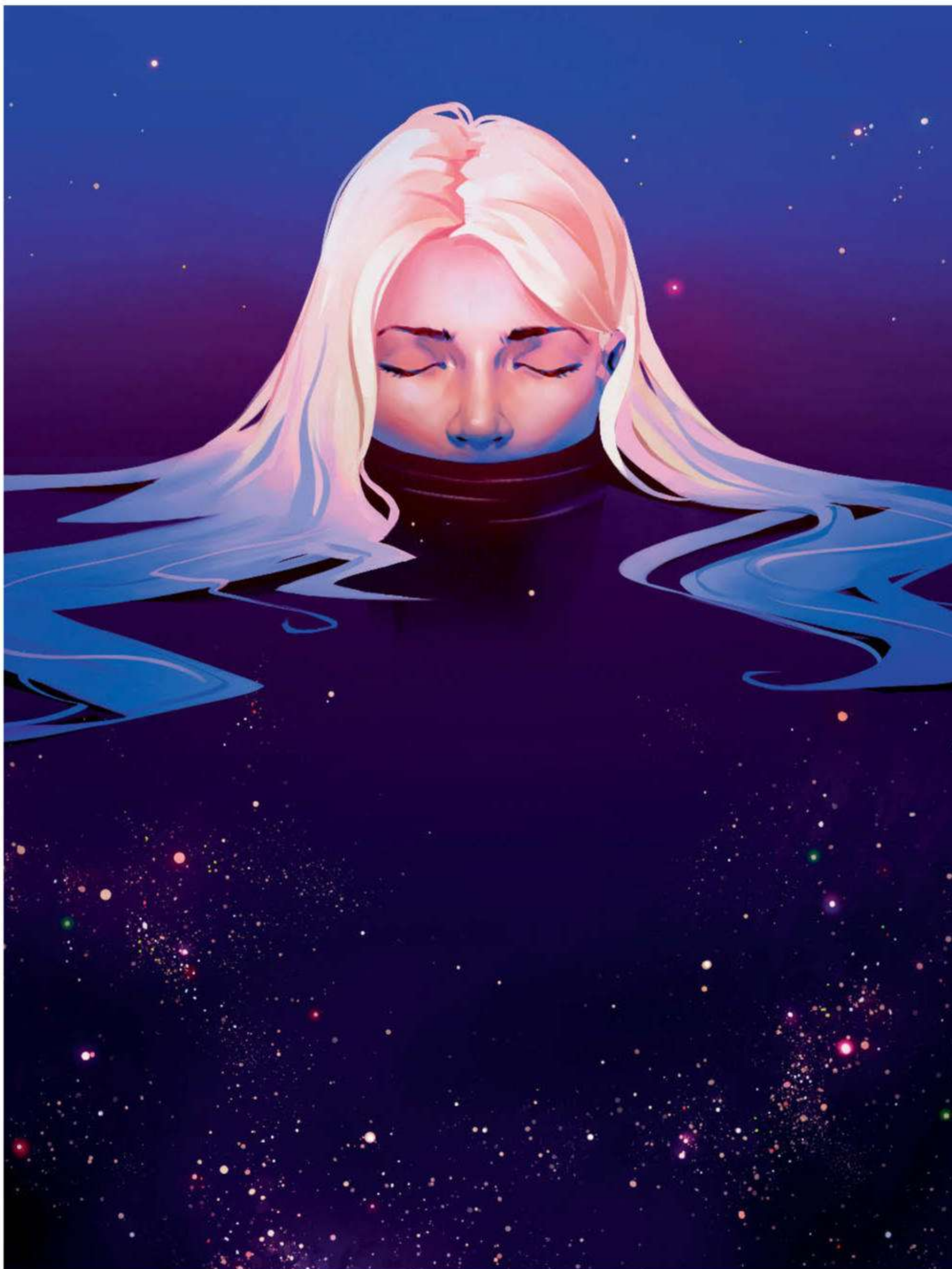
That philosophical sleight of hand changed everything. The material world became understandable as Newton and others created "universal laws" that describe how matter behaves. The achievements since have been stunning: precise, predictive models of

all known elementary particles and forces, and of the evolution of the cosmos from just after the big bang until today.

These days, precious few scientists would claim to see the mind as inherently separate from matter. Modern neuroscience has left little room inside the brain for an immaterial soul. Instead, physicalism reigns – the idea that everything in nature must be derived from the basic stuff of physics. It follows that consciousness must somehow emerge out of particles, strings, information or whatever you take as fundamental.

But while neuroscience can explain with growing precision which kinds of brain activity map onto conscious states, it is far from understanding why this brain activity gives rise to conscious experience. This is what the philosopher David Chalmers called the "hard problem" of consciousness: the seemingly insoluble question of why matter inside your skull gives rise to a personal, subjective experience of the world at all.

Some dismiss the hard problem as a red herring. They argue that consciousness is a useful illusion, or that we will explain consciousness in physical terms if only we have the patience. But philosophers and





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neuroscientists who think the hard problem is real see it as a reason to call physicalism into question. “The irony is that physicalism has done so well and explained so much precisely because it was designed to exclude consciousness,” says Goff.

For physicists, the motivation to rethink matter and mind comes primarily from another direction – their ongoing attempts to make sense of quantum mechanics, the laws that govern the behaviour of the atoms and subatomic particles that make up the deepest layer of reality we know of.

Quantum mechanics was one of two theories that revolutionised physics in the early 20th century. The other was Albert Einstein’s general relativity. This says that gravity is the result of mass warping space-time, and it ends up offering among the best examples of what physicists are striving for – an objective “view from nowhere” that has nothing to do with the individual perspective of observers.

Quantum theory was different. Experiments showed that subatomic particles manifest not in definite states – here or there, say – but as clouds of probabilities of many different possible states. That fuzziness is captured by a mathematical entity known as a “wave function”. When we make a measurement of a quantum object, the wave function is said to collapse such that the object suddenly has definite properties. The classical world we see somehow seems to arise out of quantum uncertainty thanks to our intervention. We as observers bring reality into being.

Or at least that’s one interpretation. Some argue that there is no need to invoke conscious observers to solve this “measurement problem” and instead advocate alternative interpretations. Perhaps the most notorious is that, when the wave function collapses, all possibilities play out in a near-infinite number of parallel universes. Critics of this many-worlds interpretation point out that the multiverse is an enormous price to pay to keep the mind and the observer out of the picture.

Whatever their take on the measurement problem, many physicists agree that a better understanding of observers would be a boon, and not just for understanding the quantum

“We as observers seem to bring reality into being”

world. Quantum mechanics and general relativity define observers in totally different ways, so thinking deeply about them could offer clues about how to reconcile the two to give us a unified, quantum theory of gravity.

The view from nowhere

And then there is time. Here, physics is once again at odds with our experience, in that general relativity’s view from nowhere holds that observers, including us, are just coordinates or points in a static chunk of space-time called the “block universe” – a perfect, unchanging mathematical object in which past, present and future all exist at once. If that is true, our experience of flowing time, from the past through the present and to the future, is merely an illusion.

The problem is that “a view from nowhere is not something anyone’s ever had”, says Adam Frank at the University of Rochester, New York. We presume that there is some shared, objective reality out there, but we can never

know for sure. “What quantum mechanics and what questions about time have both pressed on us is the absolute need to understand the observer, and to recognise it as a physical constituent of the world,” says Jenann Ismael, a philosopher at Columbia University in New York. For centuries, we could ignore observers with little consequence, she says. Not any more.

One option is to suggest that some form of consciousness, however fragmentary, is an intrinsic property of matter. At a fundamental level, this micro-consciousness is all that exists. The idea, known as panpsychism, rips up the physicalist handbook to offer a simple solution to the hard problem of consciousness, says Goff, by plugging the gap between our inner experiences and our objective, scientific descriptions of the world. If everything is to some extent conscious, we no longer have to account for our experience in terms of non-conscious components.

But most physicists aren’t buying that. Extending the fundamental stuff of physics to include micro-consciousness would disrupt our remarkably successful account of how the universe works, says Sean Carroll at the California Institute of Technology in Pasadena. We have little idea of what consciousness is, and so adding it directly into such precise and definitive equations could knock everything else off-kilter. “To start with the least-well-understood aspects of reality and draw sweeping conclusions about the best-understood aspects is arguably the tail wagging the dog,” Carroll wrote in a recent issue of the *Journal of Consciousness Studies* dedicated to the mind-matter question.

Goff counters that the only way to make sense of our subjective experiences, or “qualia” – such as the redness of a sunset or the sharpness of a lemon – is to treat them as new data that science must include. This new approach complements rather than contradicts physics, he says.

Where to begin? We should be sceptical of attempts to amalgamate lots of little bits of micro-consciousness to create complex consciousness, says Eleanor Knox, a philosopher at King’s College London, because it isn’t how anything else in physics works. “That’s the old-fashioned Lego brick view of



To understand the universe, we might have to rethink the idea that objects are fundamental

how we build things up in the universe,” she says. “What panpsychism doesn’t take at all seriously is the complexity of the story that we already have about emergence in the world.”

Emergence is the idea that behaviours and properties that don’t seem to exist when we look at the individual components of a complex system suddenly take shape when we see the system as a whole. Emergent phenomena are, essentially, more than the sum of their parts. Individual water molecules aren’t wet, for instance, and yet wetness is a property of water.

To create a picture of how things work at a higher level, we don’t just simply combine particles from the bottom up. If we did, we would barely be able to explain how a kettle boils – never mind why our experience of time doesn’t stack up with the timeless block universe. Instead, we have to add in top-down information. The same physical laws act on water molecules in a liquid and in a gas, but flipping the switch on your kettle changes the temperature and puts a new condition on the overall system so that

“This new cosmology is rooted not in objects, but events”

the same laws have a different effect.

Emergence gives physics new explanatory powers, says Knox – but it is far from understood. “Even thinking that fundamental physics has something to say about my coffee cup is really complicated, and there are explanatory gaps”, says Knox. Still, Carroll argues that if we can better understand the messy complexities of emergence, we might make sense of our role as observers in quantum reality. We may even find clues as to how Einstein’s smooth space-time appears out of the grainy picture depicted by quantum theory. Physicalism could yet survive.

Others advocate a more radical approach. For Smolin and Marina Cortês at the University of Lisbon, the problems we have are related in a different way. We can gain a better understanding of quantum reality – but only by accepting that conscious awareness is tangled up with the nature of time.

Together with independent philosopher Clelia Verde, Cortês and Smolin are taking tentative steps towards a new theory of quantum gravity that folds in qualia. It starts with a conviction that the timeless block universe depicted by general relativity is wrong. Instead, Smolin says that we should take our experience of time seriously and recognise that things only exist in the present moment. Nothing persists, things only happen. “For me, time is absolutely fundamental,” he says. “And there is one property that mathematical models don’t have, which is that nature seems to be organised as a series of moments.”

This leads to a very different cosmology, one rooted in present events and the relationships between them, rather than objects sitting in space-time. Each event has a view of the world that provides information about how it fits into the rest of the world – in particular, what its progenitor events in the past were and how it came to be formed from them. In this “causal theory of views”, quantum mechanics and space-time aren’t fundamental, but emerge out of this network of views of events. As events come to be, they make ambiguous possibilities definite; the unknown future becomes the present moment. And in this time-created world, physical laws aren’t fixed like Galileo or Newton supposed, but evolve through time. ➤



Intriguingly, this opens the door to qualia and conscious awareness. That is because in this picture, there are two types of events. Some events can be predicted, at least statistically, based on what has happened before. But if physical laws evolve, then there are other, rarer events whose outcome is not habitual. These totally novel events, free from precedent, allow the universe to dictate what happens next.

Near the big bang, novel events would have been very common. Consciousness would permeate the universe in a picture not unlike panpsychism. But as the universe ages, unprecedented events become much rarer. One potential wellspring of novelty today, however, is the highly complex human brain. Perhaps our brains evolved to make use of these novel events and their freedom to determine the future, says Cort  s. The idea is that our awareness results from this creative freedom.

Taming qualia

“The universe often surprises itself. Qualia are expressions of the universe to surprise,” Cort  s, Smolin and Verde propose in their contribution to the special issue of the *Journal of Consciousness Studies*.

All of which is rather bold. “I’m willing to ask questions,” says Smolin. “I don’t claim to have an answer.” But evidence may come by looking for parallels in the structure of views of events, on the one hand, and in the structure of qualia on the other – bridging the void between mind and matter opened by Galileo. A first step is to make qualia more hospitable to physics by describing, for example, how certain

“Totally novel events allow the universe to dictate what happens next”

experiences are bundled together and enter our stream of consciousness.

Accepting qualia as scientific data is just what Goff has called for. He wants physicists to go even further than Smolin and Cort  s, though. Rather than finding a home for consciousness in a physical theory, as in the causal theory of views, Goff reckons that consciousness comes first, and that it is networks of simple, conscious entities that ultimately realise the mathematical structures of physics. The challenge is to demonstrate how.

Yet Ismael sees no need for qualia, or indeed our experience of time, to take on a central role within physics. We can build up a satisfactory picture of reality, she argues, simply by examining the relations between ourselves and how we go about doing physics.

Humans have the ability to develop abstractions that are far from our actual experience, which helps when devising mathematical descriptions of nature. The

Neuroscience doesn’t explain why brain activity produces conscious experience

mistake we make is when we try to reverse that process of abstraction – when we try to start from microscopic particles, like atoms and quarks, and recover our internal experience. “The closest that we get with an objective description is brain processes,” she says. “We look at that and say: ‘That has no connection with anything that’s going on up here.’ But that’s partly because of this process of abstracting outwards.”

In this way, physical theories will always seem to be at odds with our internal self and the language of experience. The hard problem of consciousness isn’t something that physicists need to address, says Ismael. “Physics can move on without worrying about it.”

Carlo Rovelli, a theoretical physicist at Aix-Marseille University in France, takes things further still. Much of the confusion arises, he says, because we forget that all phenomena, whether mind or matter, are related to one another. This relational view, rooted in Rovelli’s research in quantum mechanics, demotes the physical objects that are usually the starting point for fundamental physics. “The best description we have about the world is in terms of the way systems affect one another,” says Rovelli.

In which case, Galileo’s distinction between subject and object is blurred, as everything is both a subject and an object – including observers and their minds. There is no view from the outside. In this way, Rovelli sees the relational universe as a “very mild form of panpsychism” in that there is something in common between mind and matter. “It is the realisation that nature is about things that manifest themselves to one another,” he says. “This takes away much of the mystery of consciousness.”

If Rovelli is on to something, it would leave us with an uncomfortable truth. The traditional stuff of physics – namely objects with absolute properties, to which Galileo devoted his life – can’t exist alone. How does that feel? ■



Thomas Lewton is a science writer based in London, UK



'Collective behaviour is what gives animals their "sixth sense"'

To better understand what really happens in the natural world, **Martin Wikelski** has created an animal version of the internet of things. The insights are staggering, he tells Matthew Ponsford

IN SEPTEMBER 2020, a blackbird flew 1530 kilometres from Belarus to Albania. As avian migrations go, it wasn't that impressive. But this journey was tracked from the International Space Station, setting in motion an ambitious project that could solve some of the biggest mysteries in animal behaviour, from how crop-eating plagues of locusts form to whether some animals possess a sixth sense to predict natural disasters.

NABIL NEZZAR ICARUS, International Cooperation for Animal Research Using Space, is the brainchild of Martin Wikelski, a director at the Max Planck Institute of Animal Behavior in Germany. His

idea, conceived two decades ago, is to create what he calls an "internet of animals" by fitting 100,000 creatures with miniaturised transmitters that supply information about them. It took a while to win the support of German and Russian space agencies and bring together a global group of collaborators, but, since that first blackbird flight, hundreds of animals have been fitted with custom-made tags weighing just 5 grams. These don't just monitor their location, they also log aspects of behaviour and physiology. A menagerie of birds, bats, goats, rhinos, tortoises and more has been sending signals to the ISS as well as ➤

"Boobies in the Indo-Pacific will tell you how strong the next El Niño will be"

Earth-based receivers. The information gathered is freely available to all. And increasing numbers of grassroots animal taggers are getting involved in ICARUS.

As the project grows, so do Wikelski's ambitions. He believes that, as well as shedding new light on animal behaviour, the internet of animals can also help us forecast environmental change, track emerging diseases, conserve endangered species and make humans more responsive to the needs of other creatures.

Matthew Ponsford: To drum up interest in ICARUS, you published a list of mysteries that it could shed new light on. Which in particular would you like to solve?

Martin Wikelski: There are hundreds, but one we want to start with is where do European eels go to reproduce? Are they really going to the Sargasso Sea and, if so, where exactly? This is all a big mystery. Another is what are the causes of death in European storks? We're planning to tag 15,000 storks a year to understand why about 70 per cent die in their first year. Where are they? I mean, if you imagine the pile of 10,000 dead storks, that's a hell of a lot. But nobody sees them die out in the wild. Also, we have massive declines in songbirds: in Europe, their numbers are down by about 600 million,

in the US, it's 3 billion birds missing. Where did they get lost? Nobody knows.

What kinds of things have you observed with ICARUS so far?

Every time we look, we see something completely unexpected and new. People only know on average what animals are doing, but no animal is average. They all do really interesting and crazy things. So we have white storks flying over the Sahara five times a season. We have cuckoos going from Kamchatka [in Russia's far east] through India to Angola and back. We have sooty terns from the Seychelles going all the way to eastern India and Sri Lanka. For us, every day is super exciting.

Other groups are watching animals from space. What does ICARUS do that's new?

It can track smaller animals, it can track more animals, and it can track their behaviour through sensors. We record temperature, acceleration, humidity, magnetometry, pressure – the kind of environmental sensing that the other satellite trackers don't have. We can track wing beats in birds, energy expenditure, foraging behaviour and see when they are excited or stressed.

Why do you call this the "internet of animals"?

This internet is, in principle, the collective of the animals, because they constantly interact with each other. It's really what you could call swarm intelligence. We are combining the terrestrial Internet of Things (IoT) with a space-based IoT. So, if an animal is close enough to connect to an Earth-based data station, then it communicates terrestrially. If it's away from these areas – if it is killed in a valley in the rainforest, if it dies over the Sahara, or whatever – then you need the satellite IoT to send and receive that information.

The interesting part is that we now know that collective behaviour is basically responsible for the "sixth sense" of animals. In the old days, people saw this as something metaphysical or crazy. But we know from physics and chemistry that, where there are interacting parts, new properties emerge. This is what you have in animals as well. With intelligent sensors that interact, you get emergent new properties that aren't visible on the lower level. That's what

we can tap into. For example, we have some early indications that animals can sense upcoming disasters like earthquakes or volcanic eruptions.

How can you put such long-held folk beliefs to the test?

The key is to work with local people who understand the animals. It's almost like a good dog handler – if you have a good person, they can search for drugs at customs. Not everybody can do that. But it works if you ask those people: 'What kinds of signs are you looking for? How can the dog tell you?' That's exactly how we start with disasters. We try to get a read-out of this black box, this sixth sense of animals, this interaction of intelligent sensors.

We're doing this now at Mount Etna in Sicily, Italy. We have goats running around, and whenever we see the goats do something crazy – it happens every few weeks or so – we predict that something is happening with the volcano. And in most cases, we are right.

We did an internal evaluation of our predictions and it was pretty powerful. We aren't yet at an early warning system, but we are getting towards these systems. And then we can go further and ask what kind of environmental features the animals could tune into. That's so far pretty much unknown. It isn't seismic information because that's easy to measure, so it must be something else.

Could animal networks also help with more mainstream predictions, such as weather forecasting?

Yes, many systems are really ripe for animal predictions. For example, the gannets and the shorebirds in the western part of Mexico – they tell you in spring how the harvest of anchovies and other fish will be in the fall, because they are already tuning in to the fry production early in the season. Or boobies in the Indo Pacific will tell you how strong the next El Niño will be because – months ahead of time – they all give up their breeding schedules. They either abandon the eggs or they don't even lay eggs. And then you know it will be a strong El Niño. We already have those kinds of long-term predictions, but we have not brought them together yet on a global scale. And that goes back to the internet of animals. That is what's coming.



Will ICARUS also allow you to predict the spread of emerging and endemic diseases?

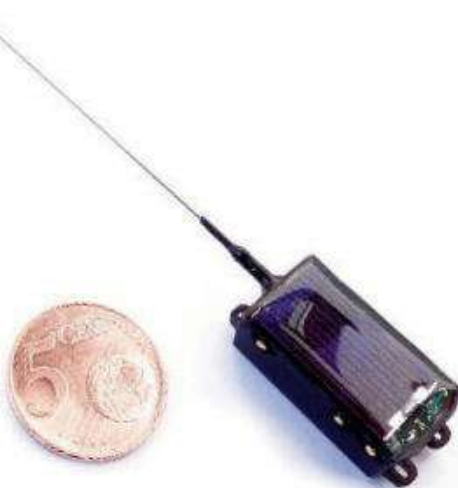
Again, yes. We already have ducks in China with tags that record body temperature, which can tell you about the next avian influenza: where that is and whether it's an important outbreak. With flying foxes in Africa, you can take a blood sample and see if an animal has encountered diseases like Ebola. Then ICARUS is almost like a coronavirus-tracking app: you know where these animals have been, and if all the ones with Ebola antibodies have been in eastern Congo, you know that's the place where they picked up the disease.

How can the internet of animals help with conservation?

One thing we're doing now is looking at how other species can help us protect animals like the rhino. In many areas of the world, corrupt rangers are working with the guys that poach rhinos. Now, we can tag the animals around them – zebras, giraffes, wildebeests, lions, wild dogs and so on – and they tell us there's something bad happening.

We are also using heart-rate loggers in blackbirds, which give a measure of stress and energy use. We want to know how expensive it is to migrate, whether it is better to stay at home or migrate. Maybe for a blackbird that's

A 5-gram tag (below) is used to track white storks and goats (above), and a 500-milligram tag will be attached to locusts



not so important, but it is for an endangered species – for shorebirds, a sea turtle or a big fruit bat in Africa. It helps us understand which habitats they need. We can also dynamically guard them. If, for example, we see that shorebirds, which in the old days flew directly from Mauritania to the Netherlands, now, with climate change, can't get enough food in Mauritania and have to land in France, we can say: "Close the beaches for three days until they recuperate." Such dynamic interactions between animals and humans are really only possible if you have animals communicating with you through these tags.

Your free online database, Movebank, allows anyone to track individual animals and get a sense of their lives and dramas. How can this help in conservation efforts?

If you say that we have lost 3 billion songbirds, nobody cares. But if we have lost Fritz and Franz and Helga somewhere between North America and South America, and there are school classes following those animals and knowing their fates and knowing them individually, it makes a total difference in conservation.

The other aspect is that people are learning the good that animals bring us. Take fruit bats in Africa: they are super important in many areas for replanting trees because they fly over open areas and spit down seeds.

What does the future hold?

We want to track the Portuguese man-o-war, a really poisonous, jellyfish-like creature. And we are working on a new, improved version of ICARUS. It will include very small tags – 500 milligrams – that will go on desert locusts. So, tracking the locust plague.

But the nice thing is, this is a bottom-up movement. It isn't directed by somebody. Every day we get requests from people around the world saying: "Hey, we want to understand our animals – give us tools to do that." Everybody wants to do that, they just don't have the means to do it yet. It's almost like giving people a microscope, or a telescope to see the stars. ■



Matthew Ponsford is a London-based journalist who writes The Manuals, a newsletter and how-to guide to ecological engineering

Rethinking trauma

The stressful events of the past two years have left many people reeling, but whether their experience qualifies as trauma is hotly debated, as **Jessica Hamzelou** reports

GIVING birth. A car accident. Racial abuse. Many of us feel we have experienced things we would describe as traumatic. Look no further than the past few years. Beyond the sickness and deaths wrought by covid-19, many psychologists warned that the pandemic was a mental health crisis in the making, with cases of post-traumatic stress disorder (PTSD) predicted to soar.

Consult the medical textbooks, however, and you find that such experiences don't generally qualify as trauma. People who suddenly lost a loved one to covid-19, and those working in hospitals and care homes might meet the criteria. But relentless news updates about a mysterious deadly disease, job loss, social isolation and living under lockdown – none of these fits the bill. "People called the pandemic traumatic, and it's not," says George Bonanno at Columbia University in New York.

In our propensity to view things as traumatic, we may also be overplaying the impact, Bonanno argues. His research has shown that, given time, most of us will recover even from the most horrifying experiences. In light of this, says Bonanno, the word "trauma" has lost all meaning. But others believe the strict medical definition should be expanded to cover a wider set of human experiences.

This explosive debate – reignited by the pandemic and the Black Lives Matter movement, and continuing at a time when

war is high on the news agenda – has big implications. Ultimately, our understanding of what trauma is, and which experiences qualify, determines whether people are being unnecessarily diagnosed and treated for PTSD, or are living with the symptoms unable to get the treatment they need.

The medical profession has long recognised the importance of trauma, even if it has struggled to define it. The first edition of the "psychiatrist's bible", the US *Diagnostic and Statistical Manual of Mental Disorders*, or DSM, published in 1952, mentions a "gross stress reaction" that can result from severe situations such as catastrophe or combat. But it wasn't until 1980 that PTSD was introduced.

The symptoms of PTSD include recurrent disturbing memories, dreams or flashbacks, stress reactions to certain cues, avoidance behaviours, low mood or feelings such as guilt or shame. Importantly, however, an experience cannot be termed traumatic unless it fits with a list of potential traumas that are collectively called "criterion A". This list has widened over the years and today includes actual or threatened death, serious injury and sexual violence. A person must have experienced, witnessed or had repeated professional exposure to one of these events, in order to qualify for a PTSD diagnosis.

The public perception of trauma has also changed, says epidemiologist Karestan



DANIEL STOLLE



Koenen at Harvard University. “When I started in the field, if you said ‘trauma’, the only thing people associated with it were war veterans,” she says. “Now, the public has a much broader view.”

This broader definition has been described by some psychologists as “concept creep”. “People use it indiscriminately now,” says Bonanno. “Suddenly, people were saying they were traumatised from relatively mundane things.” That is a problem, because if a broader range of human experiences are considered traumatic, more people will meet the criteria for a PTSD diagnosis – and some may receive unnecessary treatment as a result. “It could potentially harm them. At minimum, it would waste their time,” says Bonanno.

For others, the criteria are too narrow. In 2017, Lisa van den Berg at Leiden University in the Netherlands and her colleagues assessed PTSD symptoms in 1433 volunteers who were already participating in a study on depression and anxiety. The team found that PTSD symptoms following an event that wouldn’t meet the latest DSM criteria (DSM-5) for being traumatic were just as severe or more severe than those following an event that would be considered a trauma.

Atypical trauma

Koenen also wonders whether the criteria should be broadened. Over her years of research, she had seen women develop the symptoms of PTSD following events that wouldn’t have necessarily met the DSM-5 list, including miscarriage and sexual harassment.

In one case, a woman had been through a particularly acrimonious divorce, during which her ex-husband had kidnapped her children. “Nothing she described in that event fits on a typical trauma scale,” says Koenen. “It really challenged my thinking. How do we define trauma, and what questions should we ask?”

So, between 2018 and 2021, her team surveyed more than 33,000 current and former nurses in the US about their experiences of trauma. The survey encompassed traumas that would fit the DSM-5 definition, but also included an option for responders to describe “other” events they felt were traumatic. “That ‘other’ category has the highest prevalence of PTSD associated with it,” says Koenen. ➤

Rigidly applying the DSM-5's criteria in the pandemic could mean that people who have found the experience traumatic are unable to access treatment, argue Marielle Wathelet at Lille Regional University Hospital in France and her colleagues. "In the covid-19 pandemic, the strict application of DSM-5 criterion A could leave a large number of patients without the appropriate care," they recently wrote in a paper.

Yara Mekawi at the University of Louisville in Kentucky, who studies the impact of racial discrimination on mental health, also feels that meeting a set of criteria for trauma makes no sense. If two people have the same PTSD symptoms and the difference between them is that one person meets the DSM-5 criterion A but the other doesn't, why would they be treated differently, she asks. "It's not like there's a blood test or biological basis for it."

And yet, under criterion A, people who repeatedly witness threats to the lives of others in a professional capacity, such as police officers and first responders, qualify for a PTSD diagnosis. Why don't Black people in the US who were repeatedly exposed to distressing footage of Black individuals being manhandled and murdered over the past few years, asks Mekawi. "If you're being inundated with images of someone from your racial group being brutalised, why would that be disqualified as a criterion A trauma?" she says.

"It's a good question and I don't know the answer," says Robert Ursano at the Uniformed Services University in Bethesda, Maryland, who was one of the panel of experts who decided the DSM-5 PTSD criteria.

Ursano stresses that miscarriage and racial abuse are "tremendously terrible events, no question about it". But he maintains that there must be a threat to life – which can occur in some cases of each experience – to qualify for a PTSD diagnosis. He points to a lack of research – it isn't yet clear if these experiences lead to PTSD in the way other experiences do, he says.

While we lack the evidence to answer this question, we do have a growing body of research to answer another question: how resilient are people to trauma? And these findings are further stoking the fire around the debate.

It is perfectly normal to experience some PTSD symptoms after a potentially traumatic

New Yorkers head back to work in the days after the 9/11 attacks



event. Someone who has been in a car accident and sustained minor injuries, for instance, might have dreams about the accident, flinch at the sound of screeching brakes and temporarily avoid driving. These would all be considered symptoms of PTSD, but are to be expected following such an experience. The person would only be advised to seek treatment if the symptoms didn't begin to improve within a month or so, or if they significantly affected quality of life.

Nightmare events

For the majority of us, this doesn't happen. Most people won't develop lasting symptoms, even after horrifying experiences. For example, multiple studies suggest that around 8 per cent of people who experience the horrors of war go on to develop PTSD.

The 9/11 terrorist attacks in the US also offer up some insights. Images of planes crashing into the World Trade Center in Manhattan, New York, were broadcast globally, and the attacks dominated the news for months, particularly in the US. "Within days, there were these very dramatic pronouncements that we were heading for a mental health crisis of unprecedented magnitude," says Bonanno.

Bonanno, who was living in New York

City at the time, was one of the many people who developed symptoms of PTSD in the days following the attacks. "The planes fly right over my apartment," he says. "I had nightmares about planes crashing."

In one survey of 988 adults living in the area, conducted between five and eight weeks after the attacks, 58 per cent reported at least one PTSD symptom, with insomnia and intrusive memories being the most common. But symptoms began to ease with time. Among residents of Manhattan, the incidence of PTSD appeared to drop from around 7.5 per cent a month after the attacks to 0.6 per cent six months after the events.

Rates of PTSD were higher among those who were more directly affected by the events. A month on from the attacks, 37 per cent of those who were in the World Trade Center complex at the time had probable PTSD. A separate study by the same team suggests this figure had dropped to 15 per cent within two to three years. We can expect symptoms that developed during the pandemic to decline in the same way, says Bonanno.

In a study conducted with colleagues from Columbia University, as well as Tsinghua University in Beijing, Bonanno assessed PTSD symptoms in 326 residents of China's Hubei province between April and October 2020,



JACQUES LANGEVIN/SYGMA VIA GETTY IMAGES

“Planes fly over my apartment. After 9/11, I had nightmares about planes crashing”

Streets in Wuhan, China, are all but deserted in January 2020, as a strict lockdown is imposed



STRINGER/GETTY IMAGES

following the implementation of a strict covid-19 lockdown in January. By the end of this period, just 7 per cent of people had symptoms that might qualify for a PTSD diagnosis.

Studies like these have important take-home messages, says Bonanno. One is that simply hearing about an event doesn't necessarily make it traumatic for you. Another is that, on the whole, people tend to be remarkably resilient. “There isn't an event I've studied yet where even the majority develop PTSD,” he says. “Usually it's a very small percentage – 5 or 10 per cent.”

According to Bonanno's research, the way individuals recover from a traumatic event can take one of a handful of trajectories. Over the past few decades, he has identified three common ones.

In the resilience trajectory, people move on and continue with their lives. This is the most positive and also the most common, occurring in 62 to 73 per cent of people depending on the study.

Then there are around 7 per cent of people who tend to show high levels of PTSD in the first few months of an event, but display improvement within about six months or so. They usually recover within a year or two.

The third common trajectory is that followed by people whose PTSD symptoms last for years. Their symptoms are severe enough to affect their ability to function in life. And it can take several years for their symptoms to improve.

Even so, people are complicated, and it isn't always possible to file complex cases into one of three neat categories. And while Bonanno's recent book, *The End of Trauma*, focuses on these three trajectories, in reality, there are many more, he says.

Koenen, too, has been trying to better understand how people will respond to trauma. Since 2016, her team has been working with hospitals around the US to assess people who seek care in emergency departments following a potentially traumatic experience. Volunteers are then followed up for a year, during which they undertake surveys and cognitive tests. Blood and saliva samples are scoured for biological clues that might one day predict a person's response to trauma.

A handful of key factors have now been identified that play a role in resilience. The worst symptoms tend to develop after experiencing violence from another person,

for example. And people who have had higher amounts of trauma in their lives tend to develop more severe symptoms from further trauma.

Bonanno has found that the way a person thinks can improve their odds of recovery. He refers to a “flexibility mindset”, a set of characteristics that tend to be associated with better outcomes. In his research, people who are generally confident, optimistic and braced for challenges, as well as able to understand their situation and how to improve their lot, tend to fare the best.

This was borne out in his Hubei study: optimism and a flexible mindset, as well as good health and family support, appeared to be key to following a resilience trajectory following lockdown.

But resilience isn't a baked-in personality trait. “I don't like the term resilient, because it seems to imply that someone is resilient or not, a yes or no,” says Koenen. People might be more resilient in some aspects of life, and less so in others, for instance. Koenen has seen people who, following a trauma, perform well at school, but struggle in their relationships. “Resilience is really multidimensional,” she says.

How to boost resilience has been a hot topic of research – whether through positive thinking, meditation or even using a pill. But such approaches can be misguided, says Mekawi. “Based on my experience, people who have resources, who have stability, and who have space to process their trauma are more resilient,” she says. “I think the idea of taking a pill to boost resilience is just so bizarre. Why not change our social structure to support people?”

And given the ever-changing nature of our understanding of what trauma is, we can afford some flexibility in our definition, says Mekawi. “Trauma is a social construct... there's no single truth that everyone is going to agree on,” she says. “There's no reason to gatekeep trauma.” ■

Need a listening ear? UK Samaritans: 116123 ([samaritans.org](https://www.samaritans.org)). Visit bit.ly/SuicideHelplines for hotlines and websites for other countries.



Jessica Hamzelou is a science journalist based in London



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Science of gardening

Open a bee 'n' bee

Early spring is the time to create bee accommodation that is snug and safe for these important pollinators, says **Clare Wilson**



Clare Wilson is a reporter at New Scientist and writes about everything life-science related. Her favourite place is her allotment @ClareWilsonMed

What you need

Old log and drill (for wood-based design)

Plastic soft-drinks bottles or old pipe (for the alternative design)

Bamboo canes or hollow, woody plant stalks (for the alternative design)

MANY bee species are in decline across the world, but there are things we can do to help boost their numbers on our home turf.

I have previously covered ways to make sure your garden has lots of flowers for pollinators in order to provide their food sources, pollen and nectar. The key thing is to avoid flowers with “double” blooms, like most roses, where the reproductive parts of the flowers have been converted into extra petals, so they lack nectar.

Another way to help is to provide homes for solitary bees – the majority of bee species in the UK – which make their nests in soil, hollow plant stalks or cavities in brickwork.

If you are in a country where spring is getting going, now is a good time to make some tempting real estate for species such as the red mason bee (*Osmia bicornis*), as young individuals tend to emerge in April and May in such places. They then start looking for a place to build a nest and lay eggs.

You can buy ready-made bee hotels, although some are badly designed and large ones may encourage too many bees to live close to each other, which seems to encourage parasites. It is also possible to buy “bee bricks” for use in construction, but one study suggests that they aren't particularly favoured by bees.

Fortunately, it is easy to make your own bee hotel. One method is to take an old log and drill holes up to about 8 millimetres wide into one face. The deeper the holes, the more eggs will be put



ANDREW THOMSON/ALAMY

in each one, so make the cavities as long as possible without breaking through the other face of the log.

Starting at the bottom, the bee will lay an egg, deposit some pollen and nectar, seal it in with mud and repeat. She can lay up to 40 eggs in multiple cavities over several weeks. Another reason to make the holes deep is that woodpeckers may eat the grubs that are closest to the outside.

Another option is a bundle of bamboo canes or hollow, woody plant stalks. These can be wedged horizontally into an old pipe or a large plastic soft-drink bottle with the bottom cut off. The edge of the pipe or bottle should stick out a little further than the canes, to help keep out rain.

With either method, make sure

the ends of the canes or the holes drilled into wood have smooth edges, as any sharp splinters could tear a bee's wings, says Dave Goulson, a bee ecologist at the University of Sussex, UK.

Once constructed, fix your bee hotel in a south-facing spot, so that it gets plenty of sun, at least 60 centimetres off the ground. A site on a fence or shed is ideal, as putting it on tree trunks can leave it too shaded.

If you don't have anywhere for a bee hotel, consider helping out ground-dwelling bees by leaving a patch of dryish, crumbly soil in a sunny spot undisturbed. They will make their own holes in it. ■

Science of gardening appears every four weeks

Next week

Citizen science

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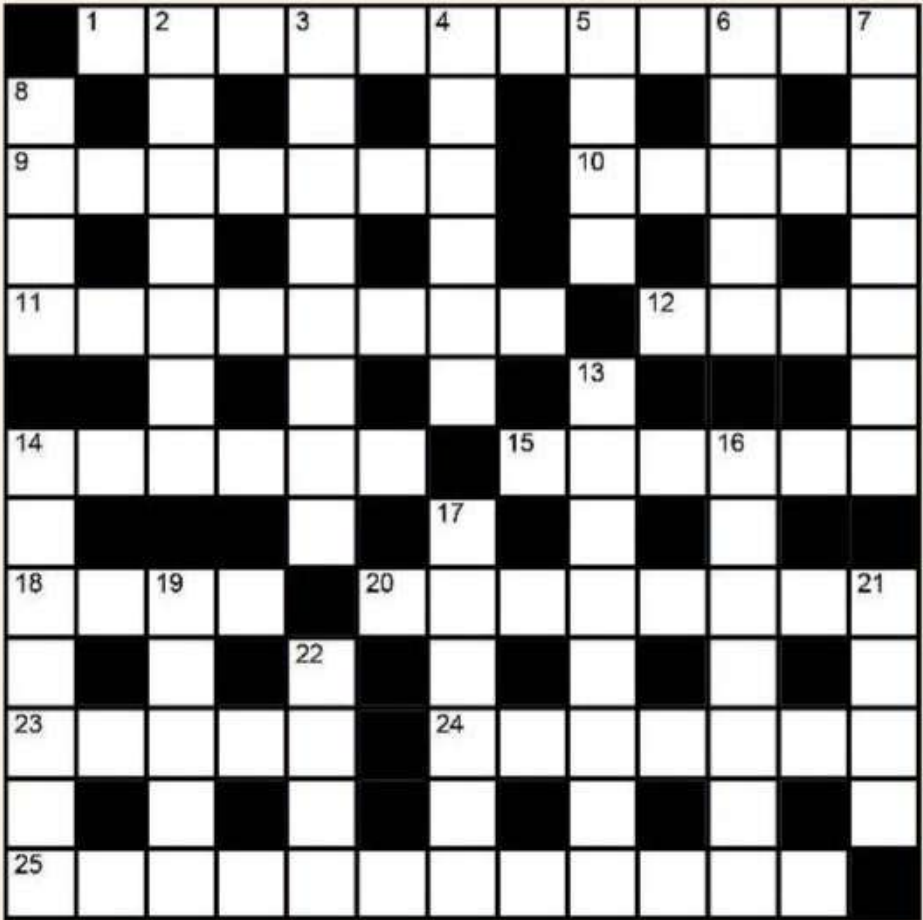
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Cryptic crossword #80 *Set by Rasa*



Scribble zone

Answers and the next quick crossword next week

ACROSS

- 1** Astronomer playing Handel melody (6,6)
9 Euphemism for rude word returns in farewell material (7)
10 Type of bond I ought to cut before the end (5)
11 Be not so haphazard in pursuit of ten synthetic lifeforms (8)
12 Hey, by the way, spreadsheet isn't filled in (4)
14 Shower participant fixed remote (6)
15 Snoops around a backed-up spring, for example (6)
18 Racetrack figures correct in retrospect, having doubled down (4)
20 Denied PM sabotaged AI company (8)
23 Treat quicklime by adding water, salt and pigment (5)
24 Spun segment of dodgy rat edutainment (7)
25 Unsurpassed study probing trail of evidence after unhinged rant (12)

DOWN

- 2** Nearly stop financially supporting court no longer in use (7)
3 Write startling word, interrupting acceptable sort of test (4,4)
4 Want day at home for all of us (6)
5 Seed case part initially doesn't appear in rainy month (4)
6 Provides diameter used in optical equipment (5)
7 You vacated island in a board game where many jaguars live (7)
8 Echo pierces mythical flower (4)
13 Hardened fill-in worker expressed hesitation with magazine VIP (8)
14 Academic includes directions for evening event (7)
16 Boy eats lean, strong-smelling cheese (7)
17 British bird name associated with Charles Darwin (6)
19 Upcoming commercial involves hard-drive feature histrionics (5)
21 Pigeon relative repeated note (4)
22 For listeners, auctions off animation collectibles (4)



Our crosswords are now solvable online
[newscientist.com/crosswords](https://www.newscientist.com/crosswords)

Quick quiz #145

- 1** How many types, or flavours, of quark are there?
2 The two types of vascular tissue in plants are the xylem and the what?
3 Following humans and chimpanzees, what was the third ape species to have its genome sequenced?
4 The layered, fossilised structures created when microbes are overlaid with sediment are known as what?
5 Where in our solar system would you find Makemake and Orcus?

Answers on page 55

Puzzle

set by Brian Hobbs
#161 Reduction deduction

"When exactly is a person supposed to celebrate their half birthday?" wondered Lionel. "I mean, you could celebrate your **182/365th birthday, or your 183/365th birthday, but unless it is a leap year, the 1/2 fraction never arrives.**"

"The world's greatest mystery," said Jill.

"But the good news is that if you write every date as a fraction, so **1 January is 1/365 and 2 January is 2/365 and so on, then my birthday falls on a day where that fraction is reducible,**" says Lionel.

"Reducible?"

"You know, can be simplified, like **12/18 can be reduced to 2/3. My birthday fraction can be reduced, but the next day can be reduced even more, to numbers on the top and bottom that are even smaller.**"

"I'll be sure to celebrate by reducing the number of presents I get you," says Jill.

When is Lionel's birthday?

Solution next week

Flat Earth

If the world were flat, how far away would a ship need to be to “disappear” from sight?

Mike Follows

Sutton Coldfield, West Midlands, UK

If we were living on a flat surface without an atmosphere, the maximum distance we could see would be limited by the ability of our eyes to resolve a ship from other nearby objects and by the ship's contrast with its background.

A ship would be seen from the greatest distance at night if it had all its lights on. The maximum distance would depend on how bright it was, its size and whether you were interested in identifying it as a ship or just detecting a few photons of light. Obviously, you could see it at even greater distances with the aid of binoculars or a telescope. If the ship were as bright as a star, you might be able to see it from 13 billion light years away.

But all these conjectures are

“It is this ability to see ‘over the horizon’, beyond our line of sight, that can give us the illusion that we live on a flat Earth”

sidestepped when we factor in our atmosphere and the refraction, scattering and absorption of light that it brings.

As the distance of the ship from us increases, so do the chances that light rays from it are refracted out of our line of sight, due to variations in air density, driven by convection.

Ironically, it is possible that we are able to see a ship from just as far on our spherical Earth. This is because the density of air decreases with height above Earth's surface so that all light rays travelling nearly parallel to the planet's surface bend downwards slightly, almost matching Earth's curvature, something that surveyors take into account.



PHOTO CREDIT

This week's new questions

Springing back If frogs return to breed at the place where they hatched, how do they spread across the country?

Stephen Yeardsley, Long Bennington, Lincolnshire, UK

Magnetic weather Does Earth's magnetic field affect the weather? **Carl Good**, Groton, Massachusetts, US

It is this ability to see “over the horizon”, beyond our line of sight, that can give us the illusion we live on a flat Earth.

Hazel Beneke

Banksia Beach, Queensland, Australia

Assuming that there is nothing blocking your view, the constraints will be the size of the ship, the atmospheric conditions and your visual acuity.

The biggest ships are about 450 metres long, but they are less than 50 metres high. If you can distinguish a 0.1-millimetre object from its background at arm's length (roughly 1 metre), with excellent vision you should be able to distinguish an object 50 metres tall at a distance of 500 kilometres. For the average person, with average sight, even

with excellent atmospheric conditions, most ships would disappear before they are that far away though.

Hillary J. Shaw

Newport, Shropshire, UK

We may be able to discern an object 1 millimetre wide at a distance of 12 metres, but we can also perceive a large range of colours. This means that a smaller object might just be discernible if it is sufficiently different in hue from its background.

The world's largest ship is the oil tanker Seawise Giant, 458 metres long, and colour contrast means we might then just see her, sideways on, with perfect visibility, in a vacuum, with 20/20 vision, at 12,000 times this distance on a flat Earth, or 5500 kilometres away.

With a decent pair of binoculars,

Frogs return to the same ponds to breed, so how do they spread to new places?

this distance could be greater, although an atmosphere, dust and refraction would reduce this.

As a related question, with some skyscrapers more than 600 metres tall, on a curved Earth, what is the greatest distance such a building can be seen from? In theory, a 600-metre-high building should be visible 100 kilometres away.

Ian Cargill

Taroona, Tasmania, Australia

The limit of our eyes' power to resolve objects is generally taken to be about 1 arc minute ($1/60^\circ$). This means that the largest ships, which have a width of about 60 metres, should remain visible to at least 200 kilometres.

I live near the mouth of the Derwent River in Tasmania and can see vessels going out to sea. We don't get such big ships, but a new Australian icebreaker, the Nuyina, has been passing recently, and it has a beam, or width, of about 26 metres. By the same criteria, it should be visible up to about 88 kilometres away.

But when I use a ship tracker as I watch it head south, it disappears about 25 kilometres away, consistent with the calculated horizon of 19 kilometres from my observation height and the height of the ship. And a telescope doesn't bring it back into view!

Nic Brough

Wellingborough, Northamptonshire, UK

The answer depends on whether you want to be able to identify it as a ship. You are able to see that a ship is there because of the light it is reflecting to your eye, but unless it is within 30 or 50 kilometres, you probably won't be able to tell that it is a ship.

Paul Bethel

London, UK

If Earth were flat, and given a good telescope, you would see the ship until it fell off the edge.



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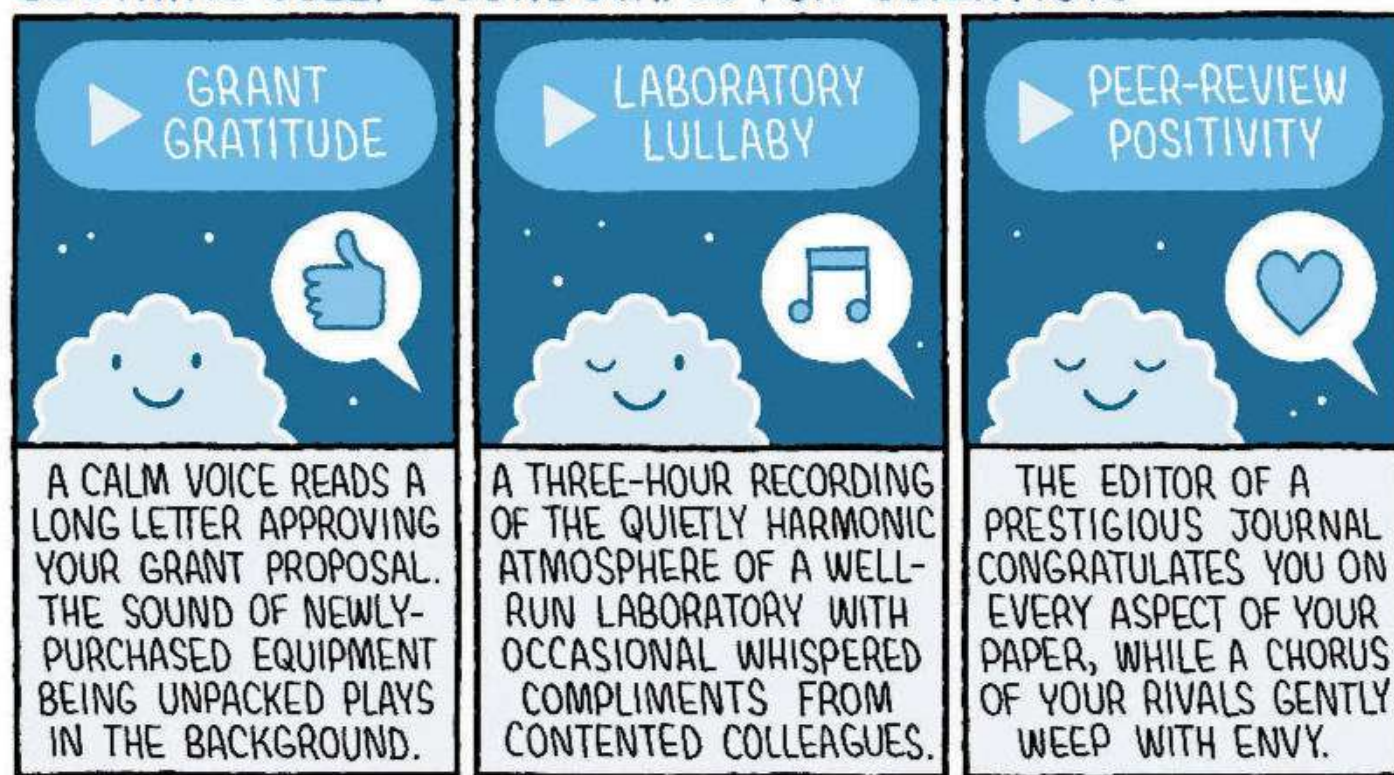
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Puppy love

Why do I love my dog when, in evolutionary terms, there are no benefits to me?

Garry Trethewey
Cherryville, South Australia

In evolutionary terms, there are benefits to being a member of a group. A person who seeks physical, emotional and social contact is more likely to survive than an outcast.

The qualities that elicit love include proximity and dependency, and characteristics such as big eyes, round features and intrusiveness – similar to those of human babies. Dogs have enough of these qualities that we expend resources on them, a bit like a cuckoo's foster parents.

David Muir
Edinburgh, UK

When you stroke and hug your dog, and your pet appreciates this, you are mutually bonding. In you, and probably your dog, this causes a cascade of the cuddle chemicals,

“Did our cooperation with wolves enable us to survive the harsh winters of Europe more successfully than Neanderthals?”

oxytocin, serotonin and dopamine. When you release these hormones, you experience improved mood, relaxation and lower levels of depression. Serotonin has also been linked to enhancing the immune system.

Human-dog tactile interaction probably does have evolutionary benefits for the human, and perhaps for the pet pooch as well.

Don Burke
Sydney, Australia

Dogs first domesticated humans about 20,000 years ago. They probably made the first move by following us around to get food. They then joined hunting groups and defended houses and villages and provided friendly companionship. There is a huge benefit for us humans.

Francis Blake
London, UK

It isn't known exactly when *Canis lupus* (the wolf) morphed into the subspecies *Canis lupus familiaris* (the domestic dog), although it is probably more than 30,000 years ago. The change presumably arose through cooperation in hunting. This would require the building of trust between the wolves/dogs and humans, and it is easy to see how, over time, this trust would become affection, on both sides.

Our modern love for dogs can be seen as a hangover from these earlier times when there would have been clear evolutionary benefits for our ancestors.

I have often wondered if the cooperation between wolf and *Homo sapiens* – presumably resulting in more plentiful meat and warm pelts – is one reason why these people survived the harsh winters of Europe more successfully than Neanderthals (I am assuming that Neanderthals didn't also domesticate the wolf).

I will leave it to others to explain why we also love cats. ■

Answers

Quick quiz #145 Answers

- 1 Six: up, down, charm, strange, top and bottom
- 2 Phloem
- 3 The Sumatran orangutan (*Pongo abelii*)
- 4 Stromatolites
- 5 The Kuiper belt, the ring of objects located beyond Neptune

Quick Crossword #104 Answers

ACROSS 8 Thorax, 9 Phthisis, 10 Wren, 11 Lymphocyte, 12 Nash, 13 Canis Major, 17 Cyst, 18 Calyx, 19 Arch, 21 Subsidence, 23 Ears, 24 Machine-gun, 28 ICBM, 29 Duodenum, 30 High-up

DOWN 1 Pharmacy, 2 Bronchitis, 3 Oxalic acid, 4 Spam, 5 Itch, 6 Zinc, 7 Distro, 14 Nylon, 15 Sixteenths, 16 Awakenings, 20 Cerebrum, 22 Uranus, 25 Hedy, 26 Nine, 27 Game

#160 Blurry-Ness Solution

The correct answer is 15 metres. When the boat reaches the ripple (point X), the ripple has been travelling for 5 seconds. When the boat crosses the other side (Y), the ripple has been travelling for 15 seconds, so the diameter of the outer ripple in the diagram is three times that of the inner ripple, so the ripple originated 1/4 of the way between X and Y. The boat took 10 seconds to cross the ripple, so reached Nessie 2.5 seconds after crossing the ripple or 7.5 seconds after taking the photo. This gives $2\text{ m/s} \times 7.5\text{ s} = 15\text{ metres}$.



On Earth...

As a fresh-faced 18-year-old, Michael Owen's mazy run from the centre circle to score against Argentina in the 1998 World Cup round of 16 raised hopes of a new golden era of English football – "soccer", we add, looking in no particular direction – just as surely as David Beckham's subsequent sending-off and the inevitable loss on penalties dashed them. Back then, it was only 32 years of hurt; by now it is getting silly.

Altogether more forward-facing is Owen's recent reinvention as a crypto guru. "Looks to me like blockchain is here to stay," he announced last month on Twitter, hence he was working with a blockchain specialist on "a really exciting new football project".

Rapid reaction on the social media site renowned for rapid unkind reaction was predictably unkind, largely along the lines that Owen possibly didn't actually know what blockchain is. If so, he is welcome to join our club any time.

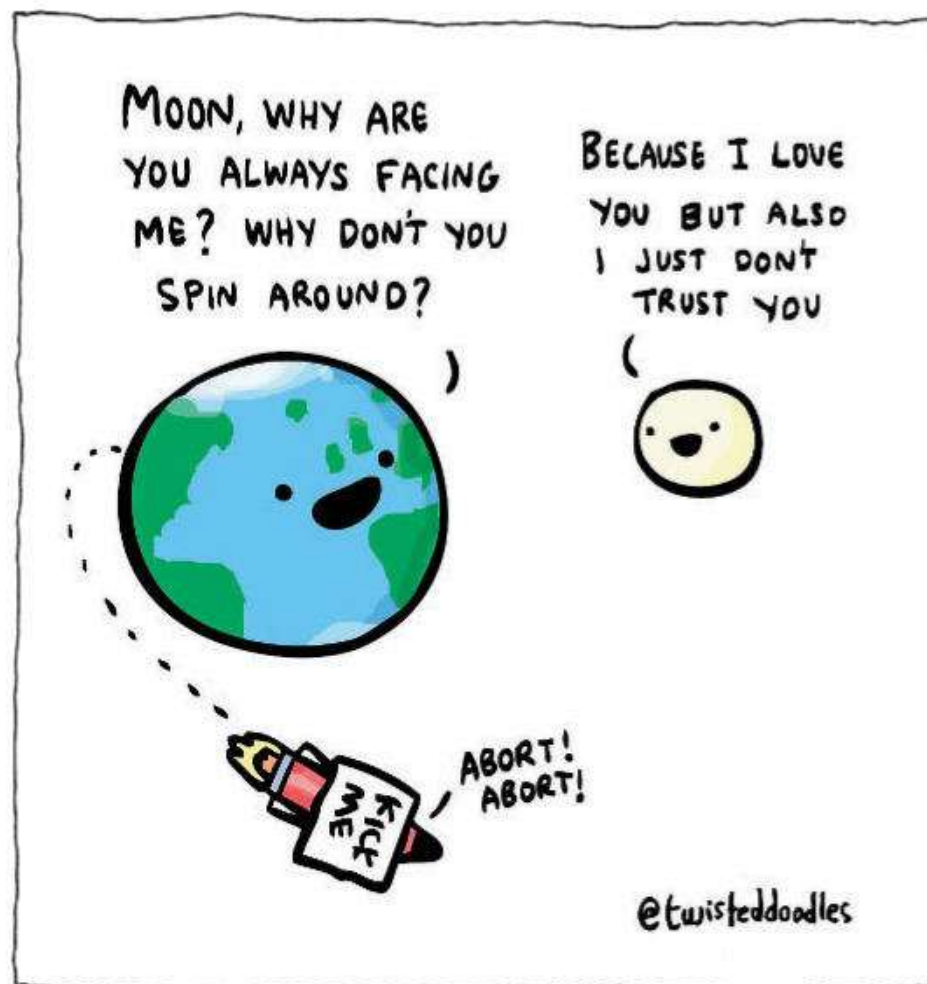
This seems to follow a trend of ex-elite sportspeople advertising cryptocurrency projects, something we can associate with the ennui and need for new revenue streams associated with being an ex-elite sportsperson. We click further, on our eternal quest for both excitement and enlightenment. "The first Michael Owen official NFT collection comprises of 1233 NFT's that are available across 5 increasingly exclusive tiers," we read. We are somewhat the wiser: the blockchain is about football stickers. Welcome to the future.

...as it is in heaven

And much, much good may come of this sort of thing, going by a press release on behalf of a "visionary NFT production house" thrust our way by a colleague with eyes not so much rolling as whirling like pulsars.

"On April 3, they're launching 30 NFTs from their bestselling 'Greatest Minds of Our Time' – pop-art images of inspirational

Twisteddoodles for New Scientist



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figures, such as Oprah, Elon Musk, and the Dalai Lama – into orbit on SpaceX," the PR puff breathlessly informs us. "Once in space, passenger Israeli air force pilot Eytan Stibb will call them up on his tablet and bless them with starlight and cosmic rays. He'll then 'drop' them from space directly into the blockchain collection."

The selection of great minds of our time is interesting, but the ultimate aim – to auction the widgets off for the benefit of clean-water charities – is laudable. The whole process does strike us as a mite overcomplicated, though, given that starlight and cosmic rays are freely available on Earth. An interesting metaphysical question is, if digital art exists only when constituted as pixels, and is called into life only when in orbit, has it been launched into orbit?

No matter. We detect a whiff of good old performance art in all this, so we will politely just nod and smile.

Small island far away

Ceri Brown writes from Haverfordwest in Wales, querying a Sky News story about the position of Henderson Island, part of the Pitcairn group in the South Pacific that through historical accident finds itself a UK Overseas Territory. Populated largely by native crabs and non-native plastic waste, it is perhaps a measure of the seriousness with which the UK has taken its stewardship up till now that the Royal Navy recently found it situated about 1.5 kilometres to the south of where it thought it was.

"Henderson Island is uninhabited and is about the size of Oxford," the article states, presumably following

the principle of British units for British places. "Could you convert that to fractions of a Berkshire please?" asks Ceri, catching us slightly off guard. No, but in standard Imperial units, it is a smidgen under 2 milliWales. That is if anyone is actually sure how big Henderson Island is.

Atmospheric surge

This admirable effort to make global news local sends us rootling in our piles for a headline from the Essex Live website in the UK sent in by Anthony Jamieson in January. "Essex sees huge atmospheric pressure surge as Hunga Tonga volcanic eruption felt across East Anglia", it screams, adding in smaller typeface that the pressure in Heybridge, Essex, jumped "from just over 1,023 millibars of pressure to 1,024". No eardrums burst, we hope.

Out of time

Gerben Wierda writes from the Netherlands currying favour – quite our favourite curryable material – and challenging the orthodoxy that true New Scientist aficionados read the magazine back to front.

"I read NS from front to back," he says, "but Feedback plays an important role in my NS backlog management. If I come across an issue and I am uncertain if it has been read, I check the first entry in Feedback." We are thus not only the most memorable bit of the magazine, he says, but "like dessert: that most enjoyable end of a good experience."

Your cheque is in the post. Of course, we recognise that the true measure of an aficionado of this magazine is a backlog of issues that you always convince yourself you are going to clear. Being stuck on the issue of 9 October 2021 has its advantages, says Gerben. "One can read news articles about the possible rise of the new delta variant of covid-19 and remain in a world that is still blissfully free of war crimes being performed in Ukraine." We hear you. ■



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